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## AIRCRAFT SHELTER-DICE THROW DATA REPORT

Air Force Weapons Laboratory  
Kirtland Air Force Base, NM 87117

March 1977

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Final Report

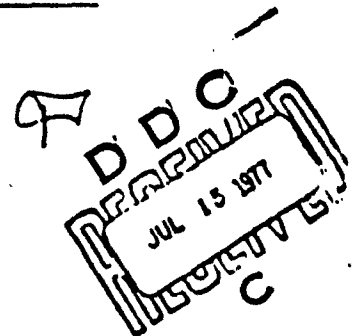
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Prepared for  
Director  
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Washington, DC 20305

AIR FORCE WEAPONS LABORATORY  
Air Force Systems Command  
Kirtland Air Force Base, NM 87117

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This final report was prepared by the Civil Engineering Division, Air Force Weapons Laboratory, Kirtland Air Force Base, New Mexico, under Job Order 21011017. Capt H. T. Webster (DES) was the Laboratory Project Officer-in-Charge.

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This technical report has been reviewed and is approved for publication.



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## SECTION I INTRODUCTION

### 1. BACKGROUND

The AIRCRAFT SHELTER-DICE THROW Project was part of the DICE THROW Series of High Explosive Tests conducted by Field Command Defense Nuclear Agency (FCDNA) at White Sands Missile Range, New Mexico. The project dealing with Aircraft Shelters was conducted by the Air Force Weapons Laboratory (AFWL) and was jointly funded by the Air Force Civil Engineering Center (AFCEC) and the Defense Nuclear Agency (DNA). This test concluded the DICE THROW Series which included a charge configuration development program (PRE-DICE THROW I), and a calibration program (PRE-DICE THROW II).

The AFWL's participation in the DICE THROW Series was directed toward satisfying Air Force Civil Engineering requirements in the area of airbase structures and involved research in support of the hardened strategic structures program (ref. 1).

The test was conducted on 6 October 1976 at 0800 hours.

### 2. OBJECTIVE

The overall objective of this project was to obtain experimental data for the development of hardened aircraft shelters by measuring and recording the following:

- a. The loading and dynamic response of a one-third scale, proposed aircraft shelter closure subjected to face-on airblast pressure (ref. 5).
- b. The response of a one-third scale TAB VEE shelter arch.
- c. One-third scale upgraded TAB VEE shelter arch when exposed side on to an airblast environment (ref. 4).
- d. The airblast and ground motion effects on a buried surface flush aircraft shelter (ref. 6).

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### 3. SCOPE

The purpose of this report is to present a summary of the test data. This summary will include the following:

- (a) A description of the site location and layout.
- (b) A description of the test shelters.
- (c) The configuration of the explosive.
- (d) Test instrumentation to outline the specifics of the instrumentation systems used to obtain motion, displacement, and stress data, the requirements for measurements, measurement list, measurement locations, and placement.
- (e) The raw and corrected data plots.



## SECTION II

### TEST DESCRIPTION

#### 1. SITE LOCATION AND LAYOUT

The AIRCRAFT SHELTER-DICE THROW test was conducted on the White Sands Missile Range, New Mexico. The test site is located 21 km (13 miles) southeast of the Stallion Range Center in the northern portion of White Sands Missile Range. The Stallion Range Center is located 138 km (86 miles) south of Albuquerque, New Mexico, on Route I-25, to the San Antonio, New Mexico, exit 19 km (12 miles) east on New Mexico Route 380 and 29 km (18 miles) south on WSMR Route 7. The site is at an elevation of 1,442 m (4,730 ft) above sea level in the northern portion of the Jornada Del Muerte Basin. The topography of the area is even, and the nearest mountains are approximately 13 km (8 miles) to the east. Figure 1 shows the site vicinity plan, figure 2 shows the site location plan, and figure 3 shows the layout of the AFBL Shelters.

#### 2. CHARGE CONFIGURATION

There were 576,000 kg (630 tons) of ammonium nitrate/fuel oil (AN/FO) which simulated a nuclear blast and shock environment for the various structures fielded in the test. The AN/FO was placed at ground zero as shown in figure 3. Figure 4 illustrates the AN/FO stack and the specifications of the charge.

#### 3. TEST CONFIGURATION

The AIRCRAFT SHELTER-DICE THROW Test provided a simulated nuclear blast and shock environment for target response and was used to confirm the empirical predictions and calculations for shock response of the shelters. One-third size models of a prototype TAB VEE shelter, TAB VEE upgrade closure, and a hard-flush shelter were tested. A brief description of each model is given below.

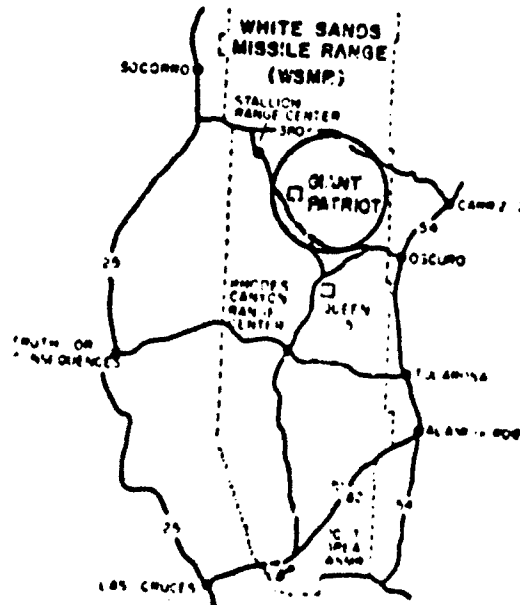


Figure 1. AIRCRAFT SHELTER-DICE THROW Test Site Vicinity Plan

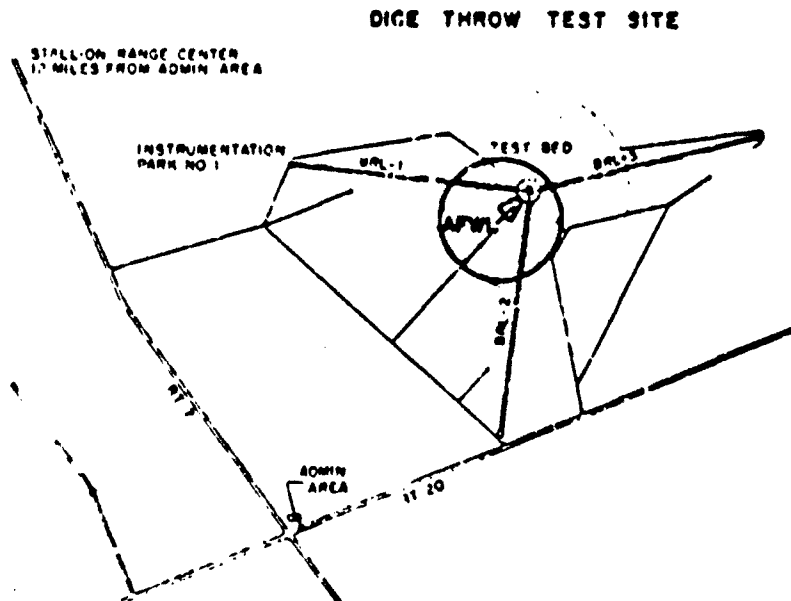


Figure 2. AIRCRAFT SHELTER-DICE THROW Test Site Location Plan

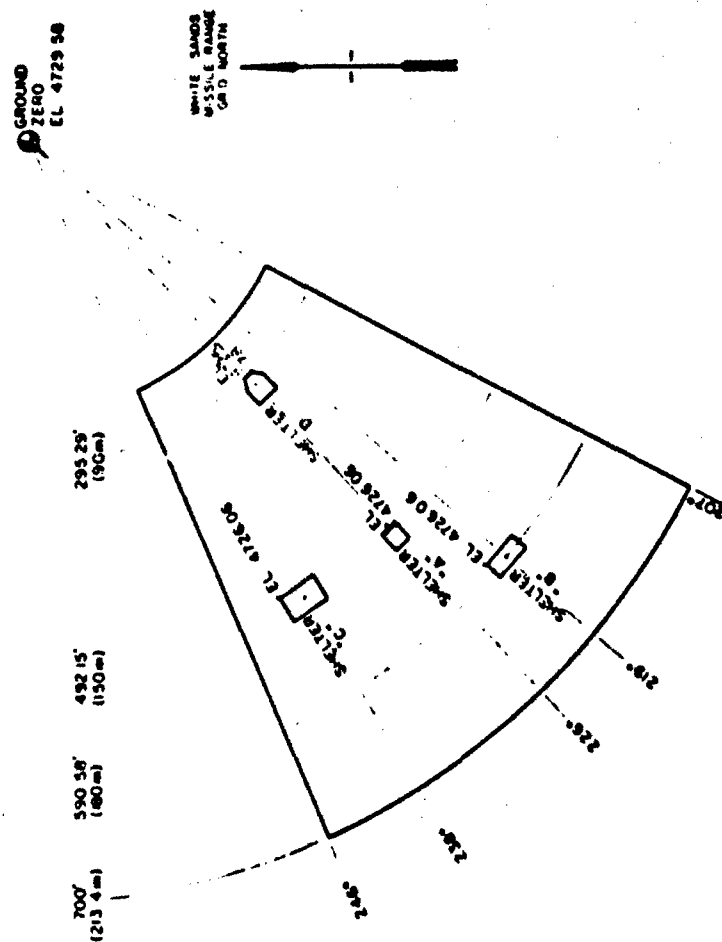
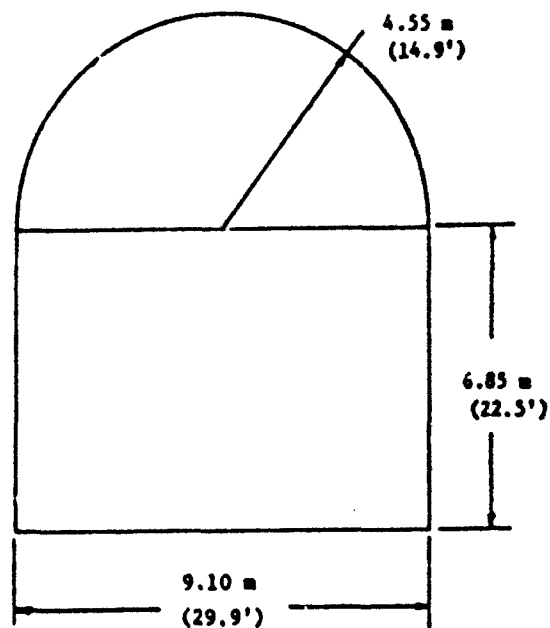


Figure 3. AIRCRAFT SHELTER-DICE THROW Test Site Layout For AFWL Test Structures



- Constructed with 22.7 kg (50 lb) bags of AN/FO and voids filled with loose AN/FO
- Initiation system consists of seven combination pentolite/octal boosters and Reynolds RP-1 detonators
- Charge density 8.5 to 9.0 kg/m<sup>3</sup> (0.031 to 0.033 lb/in<sup>3</sup>)
- Detonation velocity from 4000 to 4750 m/sec (13,000 to 15,000 ft/sec)

Figure 4. AIRCRAFT SHELTER-DICE THROW AN/FO Charge Configuration

a. Upgraded Aircraft Shelter Closure - Shelter "A", Scaled

The MIXED COMPANY Event (ref. 2) indicated that the Shelter Closure was much weaker than the arch. Because of this, it was decided that any future upgrade of the shelter should first consider upgrading the closure. A closure system was designed and developed in sufficient detail to permit testing of the system. The closure was sized for the first Generation Shelter (14 m [48'] span) and consists of a massive one-piece reinforced concrete slab, with reinforcing webs along the outer edge and at the center line.

A one-third scale model of this closure was placed face-on to the blast at a range of 150 m (492.13 ft). At this range the blast was expected to produce measurable inelastic response of the closure. However, it was not expected to produce sufficient deformation of the closure to prevent it from opening after the test. For test purposes, a short length of shelter arch was constructed to support the closure. A sketch of the closure and the support arch are shown in Figure 5. For test purposes this shelter was designated as Aircraft Shelter "A". Figure 6 is a photograph of the as-built configuration of shelter "A". The closure rolls on roller units located in a foundation trench as shown in figure 7. Figure 8 illustrates the closure during installation, and figure 9 shows the closure in the open position.

The actual inelastic response experienced by the closure did not appear to be sufficient to prevent post-test opening. However, the closure did experience sufficient rigid-body displacement to prevent it from opening after the test.

Visual observation of the closure indicated its general response was to move upward, with the top of the closure moving towards the shelter arch, and the bottom of the closure moving away from the arch, and coming to rest on the top of the foundation slot. Some shear failure was also observed in the closure panels.

Figures 10, 11, and 12 are photographs of the damage incurred on the closure.

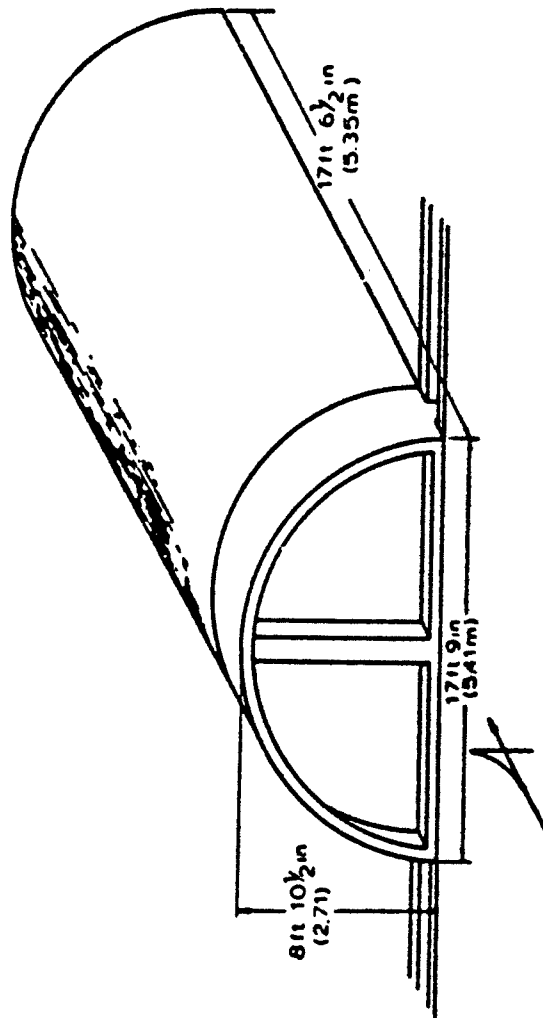


Figure 5. Upgraded Aircraft Shelter Closure - Shelter "A", Scaled

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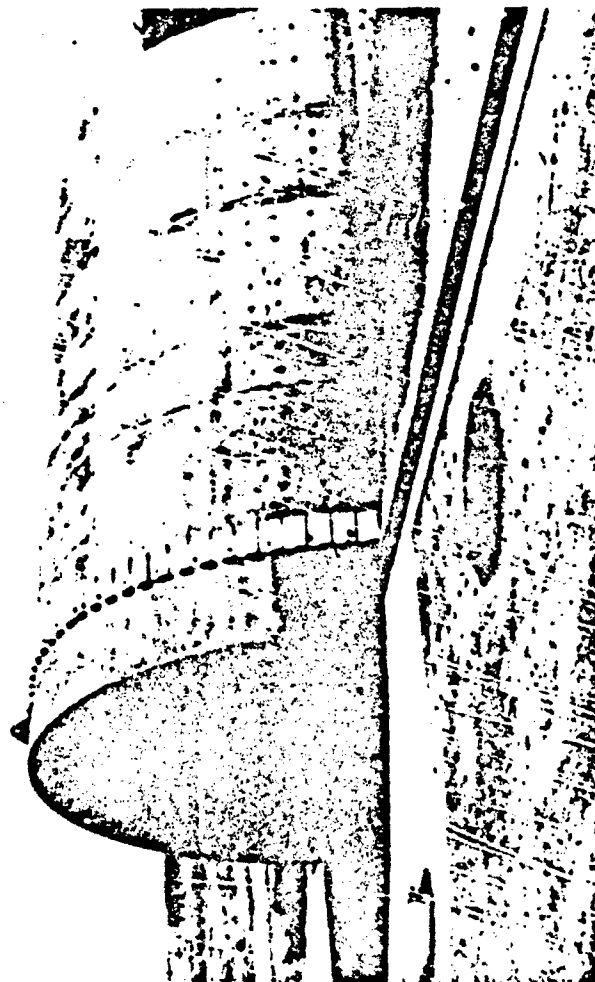


Figure 6. Shelter "A" As-Built Configuration

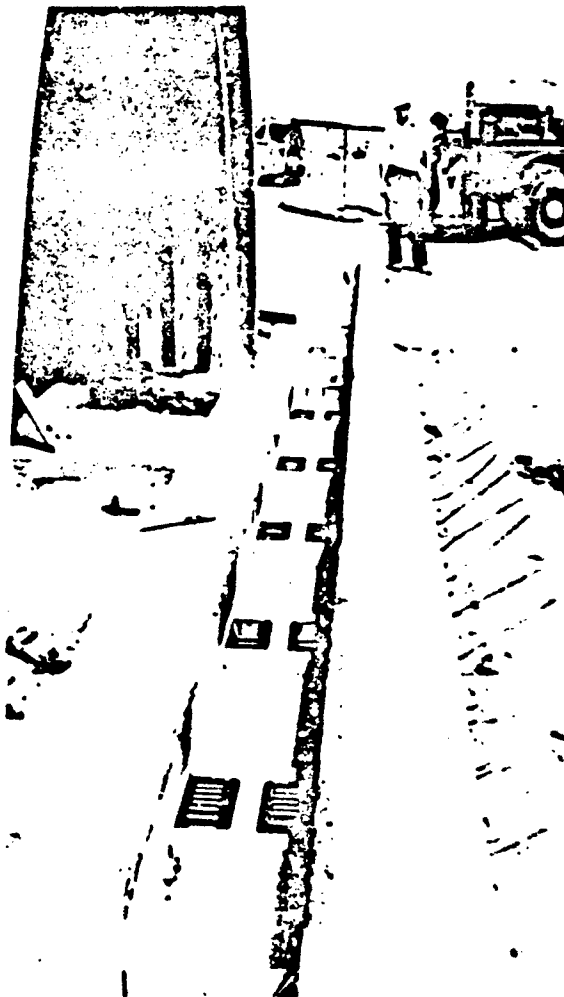


Figure 7. Shelter "A" Roller Units For Closure Located In Foundation Trench



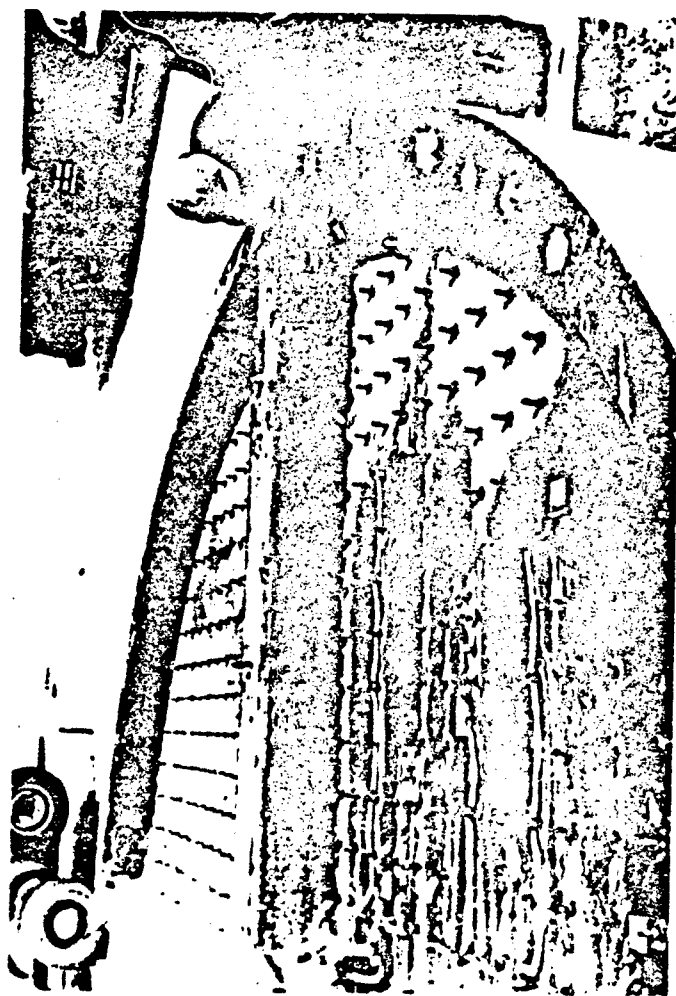


Figure 8. Shelter "A" Closure During Installation

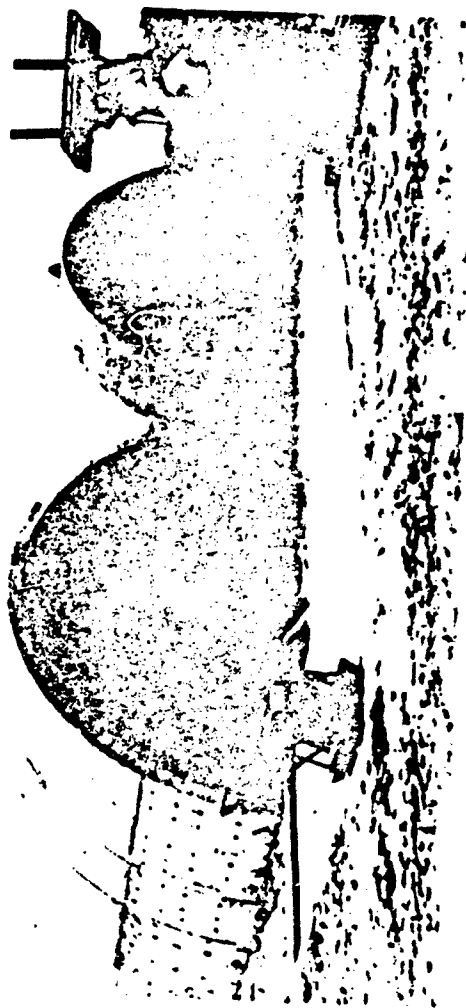


Figure 9. Shelter "A" Closure In An Open Position



Figure 10. Shelter "A" Photograph Of Damage Incurred On Closure Resulting From The Blast



Figure 11. Shelter "A" Side View Of Damage Incurred On Closure

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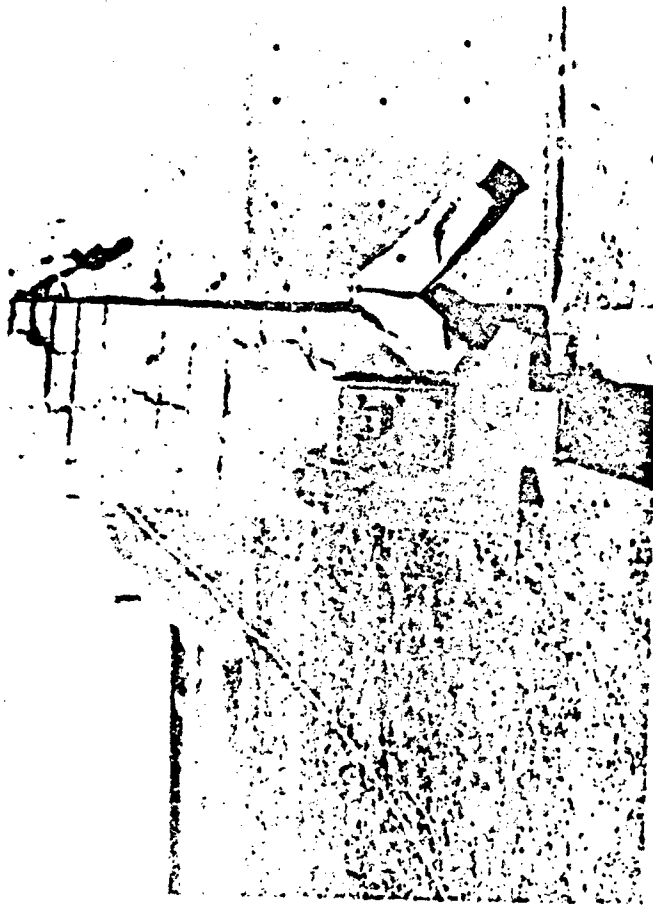


Figure 12. Shelter "A" View Of Damage Incurred On Closure Near Lower End

resulting from the blast.

(1) As-Built Construction Details

The upgraded shelter closure was fabricated by the Civil Engineering Research Facility (CERF) on Kirtland AFB, NM. It was later transported to the test site and erected on the previously constructed foundation slot and adjacent supporting shelter arch.

Photographically reduced construction drawings of the closure, foundation slot, and arch are included in Appendix A. The drawings were continuously updated as the actual construction progressed and thus reflect the as-built configuration.

Two types and sizes of reinforcing steel bar were used in the model construction of the arch and foundation slot. The no. 3 bar (9.5 mm [3/8 inch] diameter) conformed to ASTM specification A-615, with a yield strength of 410 MPa (60 ksi). The no. 2 bar was 6 mm (.236 inches) diameter reinforcing steel with strength characteristics similar to grade 60 steel (490 MPa, 71 ksi). Figure 13 is a plot of the stress/strain characteristics of the no. 2 bar.

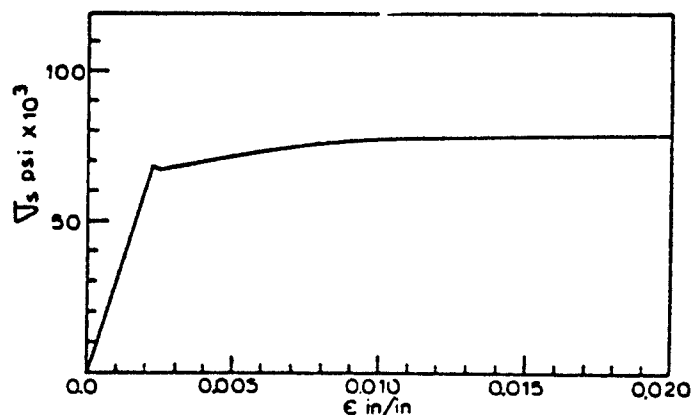


Figure 13. Stress-Strain Curve For #2 Rebar

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The steel used in constructing the closure consisted of no. 10 gage (3.4 mm [.236 inches]) thick hot rolled steel plate conforming to ASTM specification A-415, with a yield strength of 280 MPa (40 ksi).

The concrete used for the on-site construction of the shelter consisted of 20 mm (3/4 inch) maximum sized aggregate for the foundation and floor slab; and 10 mm (3/8 inch) maximum sized aggregate for the arch. The mix was designed to have a nominal 28 day strength of 28 MPa (4,000 psi). Tests were conducted on sample cylinders and the results are compiled in Tables 1 and 2. The average cylinder strength for the arch and foundation on shot day was 34.8 MPa (5,000 psi). The average cylinder strength for the closure on shot day was 27.9 MPa (4,000 psi).

The arch and closure support structure foundations were backfilled at the approximate optimum moisture content and compacted to approximately 90% AASHTO density. The footings rested on undisturbed native material.

#### (2) Instrumentation

Instrumentation for the shelter and closure consisted of 93 active electronic measurements including blast pressures, accelerometers, velocity gages, displacement gages, and strain gages. Four pressure sensitive gages were also installed in the foundation slot to measure bearing stress transmitted to the foundation slot from the closure.

As-built instrumentation layout details are contained in Appendix A. For other details on the electronic measurements see Appendix B.

All high speed camera and technical motion picture documentation were lost; however, for information purposes, the locations and perspectives of the cameras are presented in Appendix C.

#### (3) Data Presentation

The data presentation consists of the following corrected and raw data plots:

Table 1. Shelter A Results Of Concrete Cylinder Strength  
Tests For Arch And Foundation (MPa)

Cylinder No.	Age At Testing		Shot Day	Remarks
	7 Days	28 Days		
081-51	19.51 (2,829.7 psi)			
081-52		20.45 (2,966.0 psi)		
081-30		31.03 (4,500.5 psi)		Shelter Floor
081-31		30.68 (4,449.7 psi)		Shelter Floor
081-9		19.85 (2,879.0 psi)		Door, Foundation
091-9		25.51 (3,699.9 psi)		Door, Foundation
011-1	19.01 (2,760.1 psi)			Footings
021-16		27.86 (4,040.7 psi)		Arch
021-17		29.59 (4,292.2 psi)		Arch
021-18			37.30 (5,409.9 psi)	Arch
021-19			33.85 (4,909.5 psi)	Wall Footing
021-20			31.96 (4,615.4 psi)	Door, Foundation
021-21			31.37 (4,509.7 psi)	Arch
021-22			31.92 (4,629.6 psi)	Arch
021-23			35.17 (5,092.9 psi)	Floor
021-24			29.34 (4,241.4 psi)	Apron
021-25			27.13 (3,922.5 psi)	Apron
081-18		29.89 (4,332.9 psi)		Arch
081-19		30.34 (4,402.4 psi)		Arch
081-20		29.37 (4,249.1 psi)		Arch
081-21		31.30 (4,539.7 psi)		Arch
081-22		30.68 (4,449.7 psi)		Arch
081-23		29.10 (4,220.6 psi)		Arch



Table 2. Shelter A Results Of Concrete Cylinder Strength  
Tests For Closure (MPa)

Cylinder No.	Age At Testing		Shot Day	Remarks
	7 Days	28 Days		
1	22.56 (3,272.0 psi)			1st Truck Load
2	23.29 (3,377.9 psi)			1st Truck Load
3		28.41 (4,120.5 psi)		1st Truck Load
4		26.09 (3,784.0 psi)		1st Truck Load
5		25.85 (3,749.6 psi)		1st Truck Load
6		29.39 (4,262.6 psi)		1st Truck Load
7	24.75 (3,589.7 psi)			2nd Truck Load
8	26.02 (3,783.8 psi)			2nd Truck Load
9		25.61 (3,714.4 psi)		2nd Truck Load
10		27.92 (4,049.4 psi)		2nd Truck Load
11			27.92 (4,049.4 psi)	2nd Truck Load
12			27.80 (4,032.0 psi)	2nd Truck Load

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- (a) Pressure-time
- (b) Velocity-time
- (c) Acceleration-time
- (d) Displacement-time
- (e) Strain-time
- (f) Interface Pressure-time

Table 3 shows the measurement numbers for the above measurements that pertain to shelter "A". These same measurement numbers are contained on the header of each plot.

A table precedes each set of data plots, listing by the above measurement numbers, the corrections performed on that particular measurement.

The data for shelter A is presented in Appendix D.

Table 3. Shelter "A" Instrumentation,  
93 Electronic Measurements

Blast Press.	Accel.	Vel.	Displ.	Strain Steel	Rebar	Interface Proc.
29	101	225	301	461	493	551
30	102	226	302	462	494	552
31	103	227	303	463	495	553
32	104	228	304	464	496	554
33	4	229	305	465	497	555
34		230	5	466	498	
35		231		467	499	
36		7		468	500	
37				469	501	
38				470	502	
39				471	503	
40				472	504	
41				473	505	
42				474	506	
43				475	514	
44				476	515	
45				477	516	
46				478	17	
18				479		
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				39		

b. First Generation (TAB VEE) Shelter Arch-Shelter "B", Scaled

A modified one-third size TAB VEE arch structure was tested at an over-pressure range consistent with a similar test on the MIXED COMPANY test series (ref. 2). The shelter was oriented side-on to the blast at a range of 180 m (600 ft) to provide data to correlate with the MIXED COMPANY DATA. At this range the blast was expected to produce measurable inelastic response of the arch.

The model was a modified TAB VEE arch in that the doubly corrugated steel liner with 457 mm (18 inches) of lightly reinforced concrete used in the TAB VEE hardened shelters was represented by a scaled reinforced concrete T-beam without a steel liner. A separate effort to determine which type and configuration of T-beam would be most equivalent to the prototype shelter section was undertaken and is reported in reference 3. Figure 14 presents a sketch of the First Generation (TAB VEE) Shelter Arch. For test purposes this shelter has been designated as Shelter "B". Figure 15 is a photograph of the as-built configuration of Shelter "B".

Visual observation of shelter B indicated a considerable amount of inelastic response did occur. The arch deformed approximately 185 mm at the crown. Severe cracking was noticeable throughout the exterior and interior of the arch. The backwall was partially separated from the arch. Severe cracking and spalling were also evident inside the arch. The stiffener collar was severely damaged with large extensive cracks and spalling; however, it was quite obvious that the arch was much stiffer at the collar location.

Figures 16 and 17 are post-test photographs of the structure.

(1) As-Built Construction Details

This shelter was constructed by Falcon, Inc. of Socorro, NM. Photographically reduced as-built construction drawings of the shelter are contained in Appendix A.

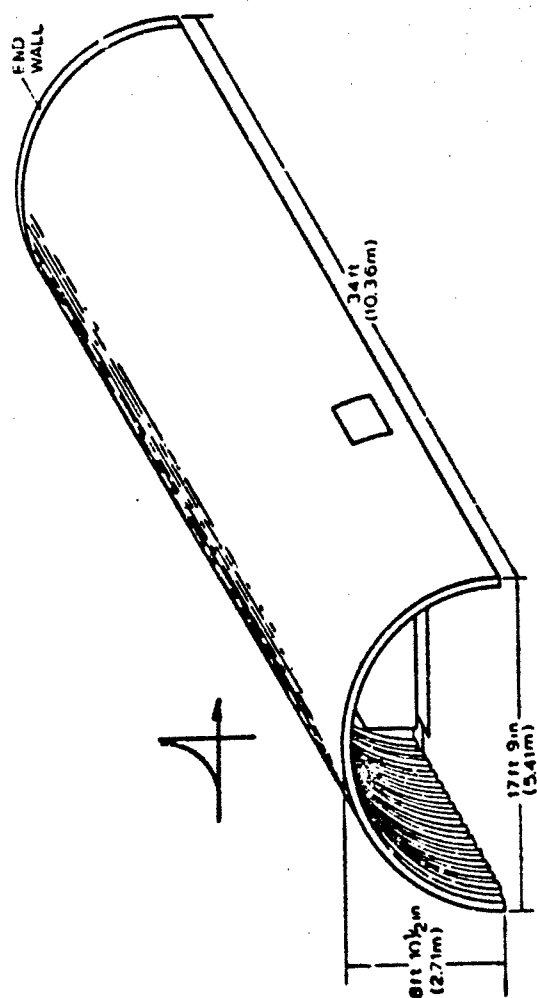


Figure 14. First Generation (TAB VEE) Shelter Arch - Shelter "B", Scaled



Figure 15. Shelter "B" As-Built Configuration

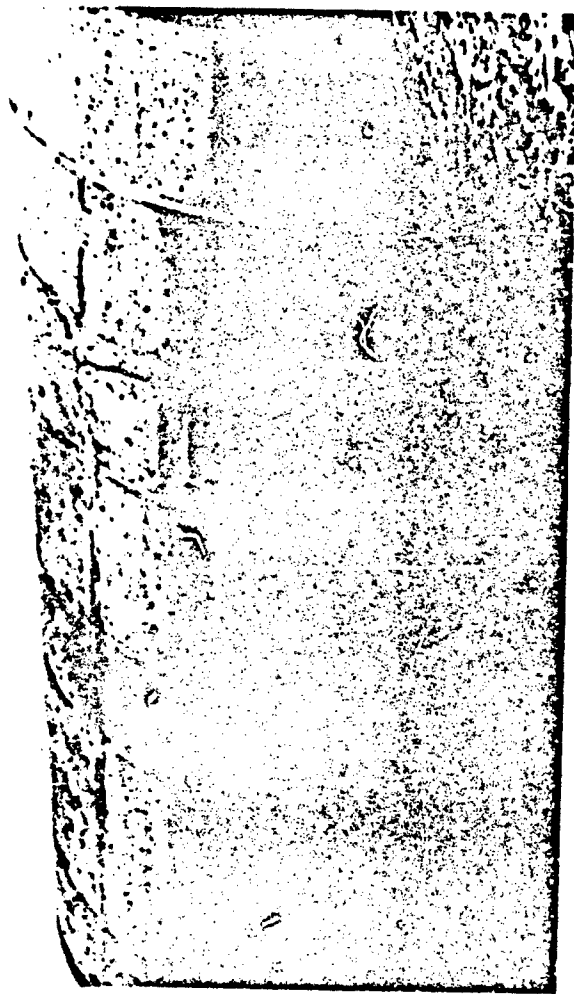


Figure 16. Shelter "B" Damage Incurred On Side Of Shelter



Figure 17. Shelter "B" Damage Incurred on Rear Wall Of Shelter



Two types and sizes of reinforcing steel were used in the model construction of the arch. The no. 3 bars (9.5 mm [3/8 inches]) conformed to ASTM specifications A-615, with a yield strength of 410 MPa (60 ksi). The no. 2 bar was 6 mm diameter reinforcing steel with strength characteristics similar to grade 60 steel. (490 MPa, 71 ksi). Figure 13 contains the stress/strain characteristics of these bars.

The concrete used for the construction of the shelter consisted of 20 mm (3/4 inches) maximum sized aggregate for the foundation, and 10 mm (3/8 inches) maximum sized aggregate for the arch. The mix was designed for a nominal 28 day strength of 38 MPa (4,000 psi). The concrete for the foundation was ready-mix concrete, transported approximately 72 km (45 miles) to the site. The arch concrete was produced on site, and placed with a concrete pump.

Tests were conducted on sample cylinders of the concrete used for various parts of the shelter. Table 4 shows the results of the cylinder tests. The average concrete cylinder strength on shot day was 34.4 MPa (5,000 psi).

The structure foundation was backfilled at the approximate optimum moisture content and compacted to approximately 96% modified AASAO density. The footings rested on undisturbed native material.

## (2) Instrumentation

Instrumentation for the shelter consisted of 54 active electronic measurements, including blast pressures, accelerometers, velocity gages, and strain gages.

As-built instrumentation layout details are contained in Appendix A. For other details on the electronic measurements see Appendix B.

All high speed camera and technical motion picture documentation were lost; however, for information purposes, the locations and perspectives of the cameras are presented in Appendix C.

Table 4. Shelter "B" Results Of Concrete Cylinder Strength Tests (MPa)

Cylinder No.	7 Days	14 Days	28 Days	Shot Day	Remarks
083-36		24.89 (3,610 psi)			Rear Wall
083-37			27.03 (3,920 psi)		Rear Wall
083-14			30.68 (4,450 psi)		Door Area
083-10	20.34 (2,950 psi)				Footing
083-11	20.13 (2,920 psi)				Footing
083-12			27.58 (4,000 psi)		Footing
083-13			19.37 (2,810 psi)		Footing
083-15			30.68 (4,450 psi)		Door Area
083-32	23.44 (3,400 psi)				Door Area
083-33	26.6 (3,860 psi)				Door Area
083-34					Door Area
083-35			35.58 (5,160 psi)		Door Area
083-35			35.10 (5,090 psi)		Door Area
CERF-7				33.30 (4,830 psi)	Footing
CERF-8				33.16 (4,810 psi)	"
CERF-14				31.44 (4,560 psi)	Intern. Door
CERF-32				33.58 (5,160 psi)	Arch
CERF-33				36.82 (5,340 psi)	"
CERF-34				32.34 (4,690 psi)	"
CERF-35				40.75 (5,910 psi)	"
CERF-53				31.92 (4,630 psi)	Rear Wall

(3) Data Presentation

The data presentation consists of the following corrected and raw data plots:

- (a) Pressure-time
- (b) Velocity-time
- (c) Acceleration-time
- (d) Strain-time

Table 5 shows the measurement numbers for the above measurements that pertain to shelter "B". These same measurement numbers are contained on the header of each data plot.

A table precedes each set of data plots, listing by the above measurement numbers the corrections performed on that particular measurement.

The data for shelter "B" is presented in Appendix E.

C. Upgraded First Generation (TAB VEE) Shelter Arch - Shelter "C", Scaled

This upgraded TAB VEE arch structure was tested, oriented side-on to the blast at a range of approximately 150 meters (500 ft). This shelter is the same as Shelter "B", but with a heavy overlay of concrete. As with Shelter "B", end walls were constructed at each end of the structure to prevent entry of blast pressure. This shelter was also a modified one-third linearly scaled model with the same reinforced concrete T-beam as shelter "B", replacing the corrugated steel liner. The upgraded portion of the model is an overlay of reinforced concrete, which is 508 mm (20 inches) thick at the crown and flared to 1.21 m (4 feet) at the foundation. A general description of the shelter is provided in figure 18. Figure 19 is a photograph of the as-built configuration of shelter "C".

Visual inspection of shelter "C" indicates, as expected, structural response remained elastic. There was very little cracking of the structural concrete.

Figures 20, 21, and 22 are post-test photographs of the structure.

Table 5. Shelter B, Measurement Numbers

Blast Pres.	Accel.	Vel.	Strain
1	105	201	401
2	106	202	402
3	107	203	403
4	<u>108</u>	204	404
5	4	205	405
6		206	406
7		207	407
8		208	408
9		209	409
10		210	410
11		211	411
12		212	412
13		213	413
<u>14</u>		214	414
14		215	415
		<u>216</u>	416
		16	417
			418
			419
			<u>420</u>
			20

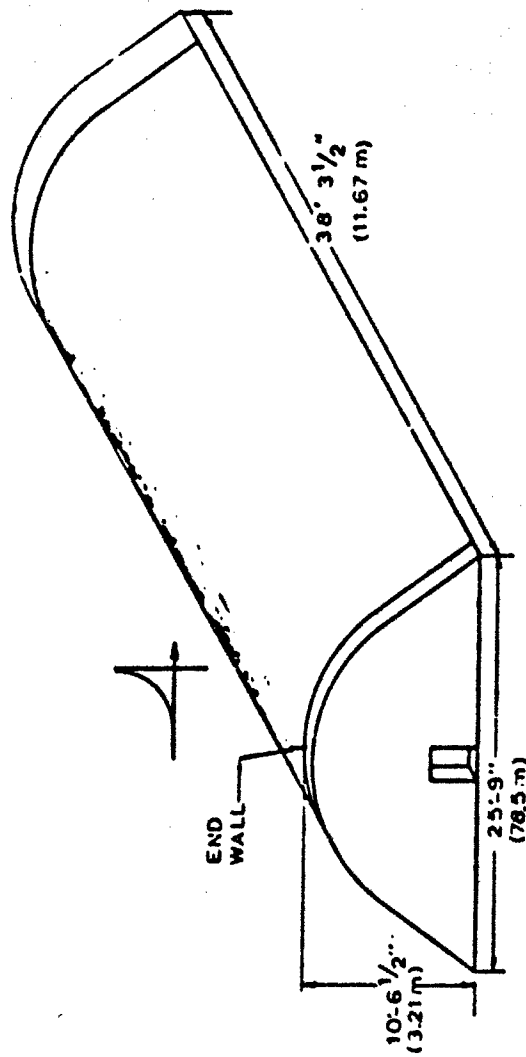


Figure 18. Upgraded First Generation (TAB VEE) Shelter Arch - Shelter "C", Scaled



Figure 19. Shelter "C" As-Built Configuration

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Figure 20. Shelter "C" Debris On Shelter Resulting From Blast

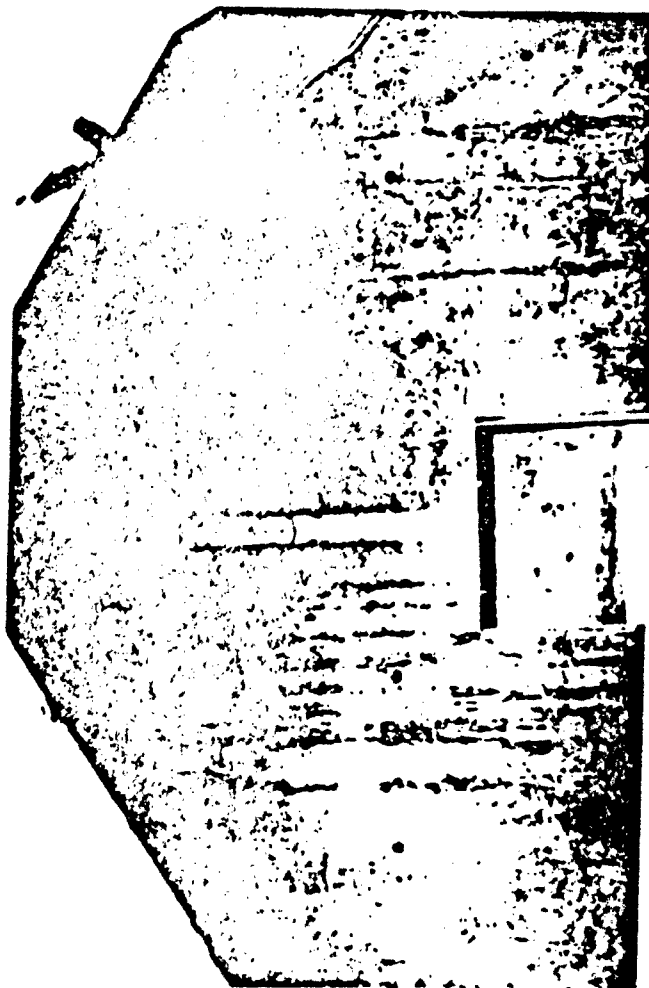


Figure 21. Shelter "C" Cracks On Front Of Shelter Resulting From Blast



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Figure 22. Shelter "C" Cracks On Roof Of Shelter Resulting From Blast

(1) As-Built Construction Details

This shelter was also constructed by Falcon Inc. of Socorro, NM. As built construction drawings of the shelter are contained in Appendix A.

The same types and sizes of reinforcing steel were used in this shelter as in shelter "B".

The same concrete mix, hauling, and placing procedures were used for shelter "C" as for shelter "B". Table 6 contains the results of the sample concrete cylinder tests taken on the concrete used in the shelter. The average concrete cylinder test strength on test day was 31.3 MPa (4500 psi).

The structure was backfilled at the approximate optimum moisture content and compacted to approximately 98% modified AASHTO density. The footings rested on undisturbed native material.

(2) Instrumentation

Instrumentation for the test structure consisted of 74 active electronic measurements, including blast pressures, accelerometers, velocity gages, and strain gages.

As-built instrumentation layout details are contained in Appendix A. For other details on the electronic measurements see Appendix B.

All high speed camera and technical motion picture documentation were lost; however, for information purposes, the locations and perspectives of the cameras are presented in Appendix C.

(3) Data Presentation

The data presentation consists of the following corrected and raw data plots:

- (a) Pressure-time
- (b) Velocity-time
- (c) Acceleration-time
- (d) Strain-time

Table 6. Shelter "C" Results Of Concrete Cylinder Strength Tests (MPa)

Cylinder No.	7 Days	Age At Testing 14 Days	28 Days	Shot Day	Remarks
083-4	22.48 (3,260 psi)		27.23 (4,890 psi)		Footings
083-5					"
083-6					"
083-7	21.86 (3,170 psi)		35.38 (5,160 psi)		Arth
083-24			33.37 (4,840 psi)		"
083-25			33.63 (4,880 psi)		"
083-27			32.89 (4,770 psi)		"
083-28			34.13 (4,950 psi)		"
083-28			31.03 (4,500 psi)		"
083-29			29.92 (4,340 psi)		"
083-38		27.23 (3,950 psi)			Upgrade Footing
083-39			28.48 (4,130 psi)		"
083-40		21.72 (3,130 psi)			Upgrade Backwall
083-41			28.20 (4,090 psi)		"
083-42			30.41 (4,410 psi)		"
083-43			30.56 (4,490 psi)		"
083-44		26.75 (3,880 psi)			Upgrade Front Wall
083-45			29.92 (4,340 psi)		"
083-46			31.65 (4,590 psi)		"
083-47					Upgrade Side Footing
083-48			27.99 (4,060 psi)		"
083-49			29.72 (4,310 psi)		"
083-50			30.41 (4,410 psi)		"
083-53			27.71 (4,020 psi)		Upgrade Overlay
083-54			27.92 (4,050 psi)		"
083-55			27.92 (4,050 psi)		"
083-56			29.44 (4,270 psi)		"
083-57			29.51 (4,280 psi)		"
083-58			28.20 (4,090 psi)		"
083-59			28.48 (4,130 psi)		"
083-60			27.99 (4,060 psi)		"
083-61			28.61 (4,150 psi)		"
083-62			28.96 (4,200 psi)		"
083-63			28.89 (4,190 psi)		"
083-64			28.20 (4,090 psi)		"
083-65			27.72 (4,070 psi)		"

Table 6 (Cont'd)

Cylinder No.	Age At Testing		Shot Day	Remarks
	7 Days	14 Days		
	28 Days			
OS3-66	29.37 (4,260 psi)		36.20 (5,250 psi)	Upgrade Overlay
OS3-67	27.58 (4,000 psi)		33.23 (4,820 psi)	"
OS3-68	27.58 (4,000 psi)		36.13 (5,240 psi)	"
OS3-69	30.13 (4,370 psi)		35.92 (5,210 psi)	"
OS3-70	29.58 (4,200 psi)		40.27 (5,840 psi)	"
CENF-3			33.51 (4,660 psi)	Arch
CENF-4			35.10 (5,090 psi)	Footings
CENF-5			37.44 (5,430 psi)	Arch
CENF-24			36.34 (5,260 psi)	"
CENF-25			35.37 (5,130 psi)	"
CENF-26			28.41 (4,120 psi)	"
CENF-27			27.37 (3,970 psi)	Upgrade Overlay
CENF-28			28.06 (4,070 psi)	"
CENF-29			25.36 (3,680 psi)	"
CENF-31			20.34 (2,950 psi)	"
CENF-41			29.72 (4,310 psi)	"
CENF-42			27.79 (4,030 psi)	"
CENF-43			24.06 (3,490 psi)	"
CENF-44			22.06 (3,200 psi)	"
CENF-45			31.72 (4,600 psi)	Upgrade Footings
CENF-46			29.79 (4,320 psi)	"
CENF-47			33.79 (4,900 psi)	"
CENF-48				
CENF-49				
CENF-50				
CENF-51				
CENF-52				

Table 7 shows the measurement numbers for the above measurements that pertain to shelter "C". These same measurement numbers are contained on the headers of the data plots.

A table precedes each set of data plots which lists by the above measurement numbers the corrections performed on each measurement.

The data for shelter "C" is presented in Appendix F.

#### D. Hard Flush Aircraft Shelter - Shelter "D", Scaled

The fourth structure tested in the event was a one-third size model of a Boeing designed underground aircraft shelter. The model did not include a hydraulic elevator system as in the prototype design. This item was eliminated as a cost savings factor. Figure 23 is a sketch of the Hard Flush Aircraft Shelter. For test purposes, this shelter was designated as Shelter "D". Figures 24 and 25 are photographs of shelter during construction. Figure 26 is a photograph of the completed shelter with the AN/F0 charge in the background.

The purpose of testing the model was to obtain experimental verification of the airblast and related ground shock protection level afforded by this advanced shelter concept.

The shelter was buried at a distance of 90 m (295.3 ft) from ground zero with the top flush with the ground. The shelter was exposed to 2.1 MPa (265 psi) incident overpressure level.

Visual observation of the test structure post-test indicated it sustained minor damage only. There were diagonal cracks at the top corners of walls toward ground zero, (see Figure 27). There were also several cracks running parallel on top of the roof, perpendicular to the ground zero azimuth, (see Figure 28). Damage inside the shelter was limited to minor cracks, and one large spall on the fixed cantilever roof. See Figures 29 and 30. A large steel frame placed in the shelter to support hydraulic jacks, for lifting of the roof pre- and post-test was moved only about 6 mm, (1/4 inch), (see Figure 31).

Table 7. Shelter C, Measurement Numbers

<u>Blast Pres.</u>	<u>Accel</u>	<u>Vel</u>	<u>Strain</u>	
15	109	213	421	-Continued-
16	110	214	422	432
17	111	215	423	433
18	<u>112</u>	216	424	434
19	4	217	425	435
20		218	426	436
21		219	427	437
22		220	428	438
23		221	429	439
24		222	429	440
25		223	431	<u>41</u>
26		224	432	
27		236	433	
<u>28</u>		237	434	
14		238	435	
		<u>239</u>	436	
		16	437	
			438	
			439	
			440	
			441	
			442	
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			449	
			450	
			451	
			452	

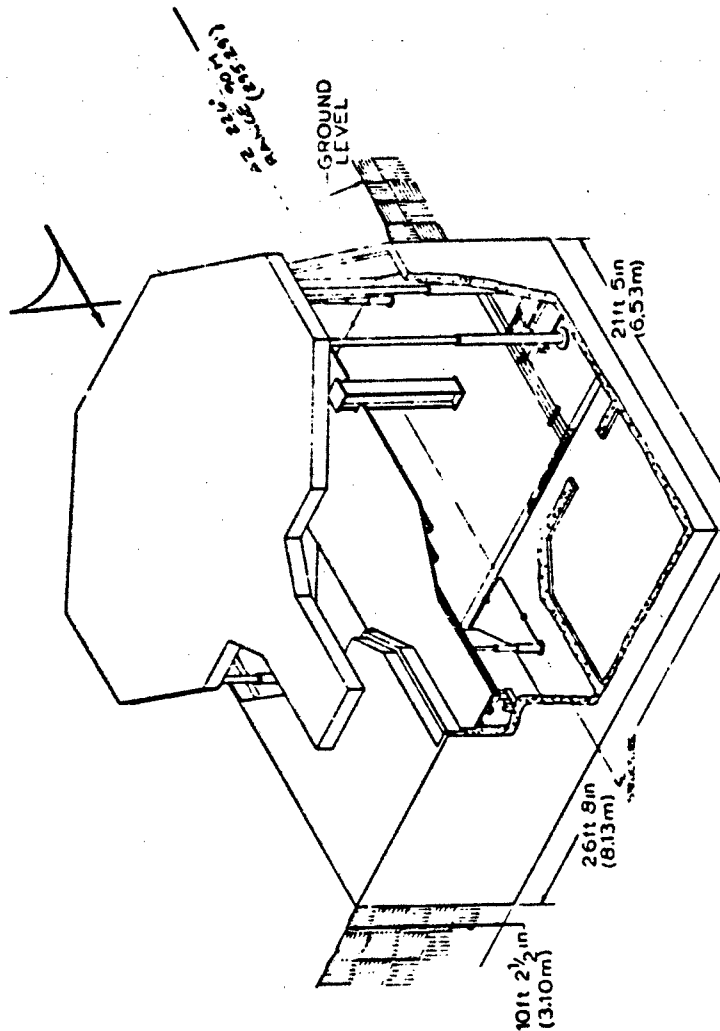


Figure 23. Hard Flush Aircraft Shelter - Shelter "D", Scaled



Figure 24. Shelter "D" Approximately 30. Complete



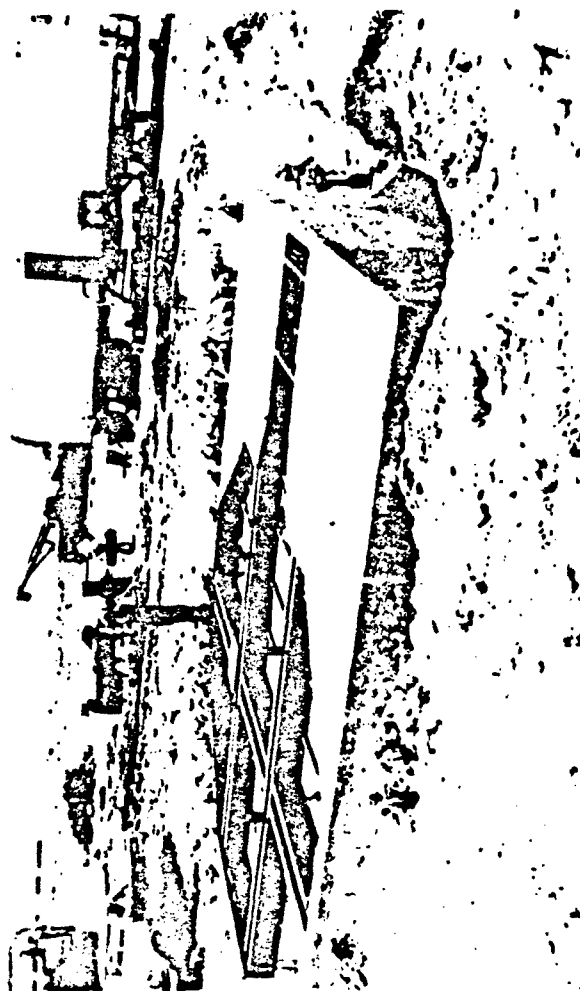


Figure 25. Shelter "D" Approximately 95% Complete

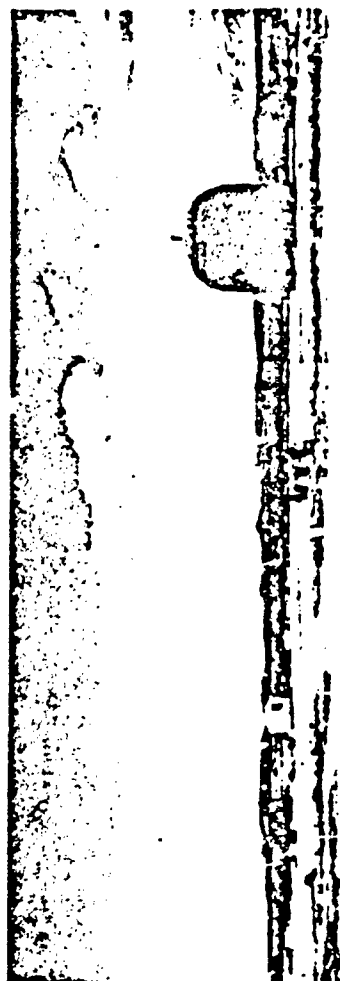


Figure 26. Shelter "D" Complete and Charge Configuration In Background

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Figure 27. Shelter "D" Diagonal Cracks On Top Of Corner Resulting From Blast



Figure 28. Shelter "D" Cracks Running Parallel On Top Of Roof Resulting From Blast

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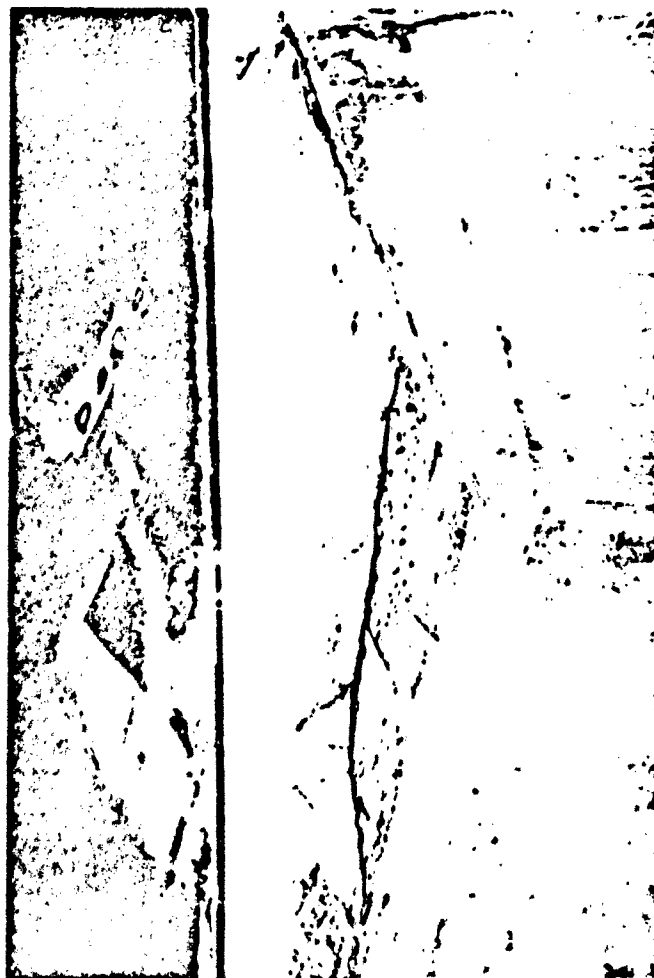


Figure 29. Shelter "D" Damage Inside Of Shelter

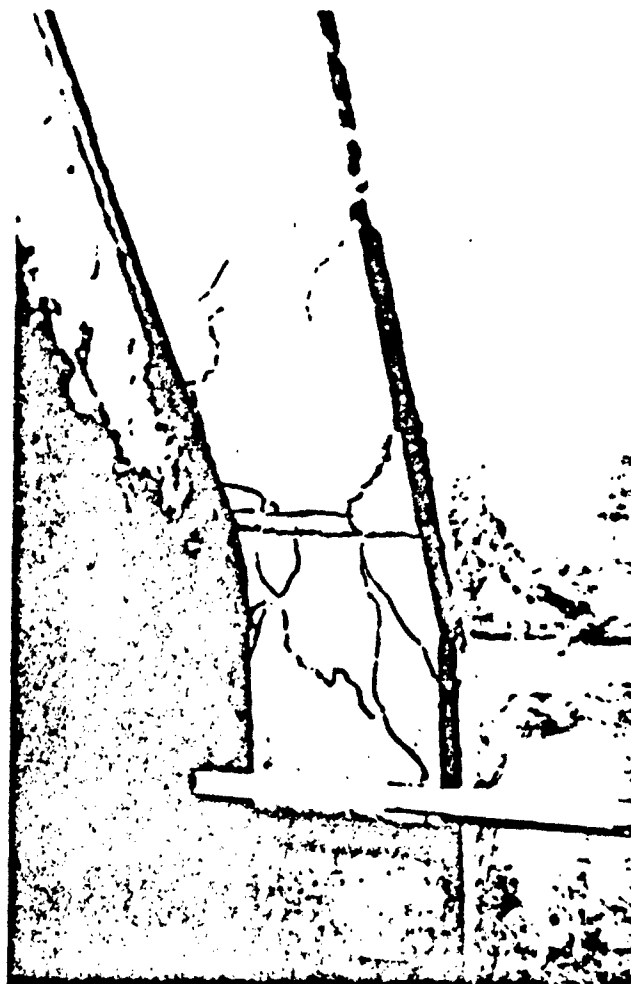


Figure 30. Shelter "D" Damage On Corner Of Shelter



Figure 31. Shelter "D" Displacement Of Steel From Inside Of Shelter

(1) As-Built Construction Details

The Hard Flush Aircraft Shelter was constructed by the Rutherford Construction Company of Albuquerque. Photographically reduced as-built construction drawings of the shelter are contained in Appendix A.

Four different sizes of reinforcing steel were used in the model construction, all of which conformed to ASTM Specifications A-615, Grade 60, with a yield strength of 410 MPa (60 ksi).

Seven different thicknesses of steel plates were used in the construction. All plates conformed to ASTM Spec. A-36.

The concrete was batched on site and consisted of 20 mm (3/4 inch) maximum-sized aggregate. The mix was designed to have a nominal 28-day strength of 28 MPa (4,000 psi). Tests were conducted on sample cylinders of the concrete used for the various parts of the shelter. Table 8 shows the results of the concrete cylinder tests. The average strength of these tests on test day was 33.5 MPa, (4,850 psi).

The shelter walls were backfilled at the approximate optimum moisture content and compacted to an average modified AASHO density of 94.5 percent.

(2) Instrumentation

Instrumentation for the shelter consisted of 76 active electronic measurements, 16 of which were in the free field. The 16 free field gages were on the centerline of the structures, and 3 m (9.8 ft) from either edge of the structure toward and away from ground zero. Other measurements included blast pressures, accelerometers, velocity gages, strain gages, and interface pressure gages. The As-Built instrumentation layout details are contained in Appendix A. For other details on the electronic measurements, see Appendix B.

All high speed cameras and technical motion picture documentation of the shelter during the test event were also lost because of a switch being accidentally activated prior to the test event. However, for information purposes, the



Table 8. Shelter "D" Results Of Concrete Cylinder Strength Tests (MPa)

<u>TEST NO.</u>	<u>1 Day</u>	<u>28 Days</u>	<u>Shot Dev</u>	<u>Remarks</u>
103-27	25.16 (3650 psi)			More than Reef
103-28	26.40 (3930 psi)			"
103-29	25.79 (3740 psi)			"
103-30		34.96 (5070 psi)		"
103-31		32.13 (4660 psi)		"
103-32		34.34 (4990 psi)		"
103-33		33.35 (4910 psi)		"
103-21	21.10 (3060 psi)			Shelter Head Works
103-22	22.61 (3280 psi)			"
103-23	20.32 (2950 psi)			"
103-24	27.06 (3930 psi)			Shelter Walls
103-16	21.72 (3150 psi)			Shelter Walls
103-17	21.24 (3080 psi)			Shelter Walls
106-5	23.30 (3380 psi)			Shelter Footings
106-6	23.02 (3370 psi)			"
106-7	21.10 (3060 psi)			"
103-15		31.65 (4590 psi)		Shelter Walls
103-19		33.37 (4840 psi)		"
103-20		33.65 (4890 psi)		"
103-8		29.72 (4310 psi)		Shelter Footing
103-9		30.20 (4380 psi)		"
103-24		31.30 (4540 psi)		Shelter Headworks
103-25		30.68 (4450 psi)		"
103-26		29.73 (4340 psi)		"

Table 8. (Cont'd)

<u>CYLINDER NO.</u>	<u>7 Days</u>	<u>28 Days</u>	<u>Shot Day</u>	<u>Remarks</u>
CERF-9			32.96 (4790 psi)	Shelter Footings
CERF-10			31.85 (4620 psi)	" "
CERF-11			33.65 (4930 psi)	" "
CERF-12			33.51 (4860 psi)	" "
CERF-15			33.23 (4820 psi)	Interior Floor
CERF-16			33.61 (5310 psi)	" "
CERF-17			34.34 (4980 psi)	Shelter Wall
CERF-21			29.23 (4240 psi)	" "
CERF-22			32.89 (4770 psi)	Shelter Headworks
CERF-23			30.32 (4470 psi)	" "
CERF-36			35.20 (5250 psi)	Movable Roof
CERF-39			34.33 (5270 psi)	" "
CERF-40			36.74 (5330 psi)	" "

locations and perspectives of the cameras are presented in Appendix C.

One of the photo poles shown in Appendix C behaved much like a passive scratch gage and showed the relative vertical motion of the shelter floor and the bottom of the moveable roof. The photo pole is labeled "Target for Camera #1" in Appendix C, and a photograph of it is shown in Figure C-3. The scratch on the pole indicated a relative vertical motion of approximately 35 mm (1-5/16").

### (3) Data Presentation

The data presentation consists of the following corrected and raw data plots:

- (a) Pressure-time
- (b) Velocity-time
- (c) Acceleration-time
- (d) Strain-time
- (e) Interface Pressure-time

Table 9 shows the measurement numbers for the above measurements that pertain to shelter "D". These same measurement numbers are contained on the headers of the plots.

A table precedes each set of data plots which lists by the above measurement numbers the corrections performed on each measurement.

The data for Shelter D is presented in Appendix G.

Table 9. Shelter D, Measurement Numbers

<u>Blast Press.</u>	<u>Accel</u>	<u>Vel</u>	<u>Interface Pres</u>	<u>Strain</u>
47	113	240	554	517
48	114	241	555	518
49	115	242	556	519
50	116	243	557	520
51	117	246	558	521
52	118	247	559	522
53	119	248	560	523
<u>7</u>	120	249	561	524
	121	250	<u>562</u>	525
	122	251	9	526
	123	256		527
	124	253		528
	125	254		529
	126	255		530
	127	256		531
	128	257		532
	<u>129</u>	258		533
	17	<u>259</u>		534
		18		535
				536
				537
				538
				539
				540
				<u>541</u>
				25

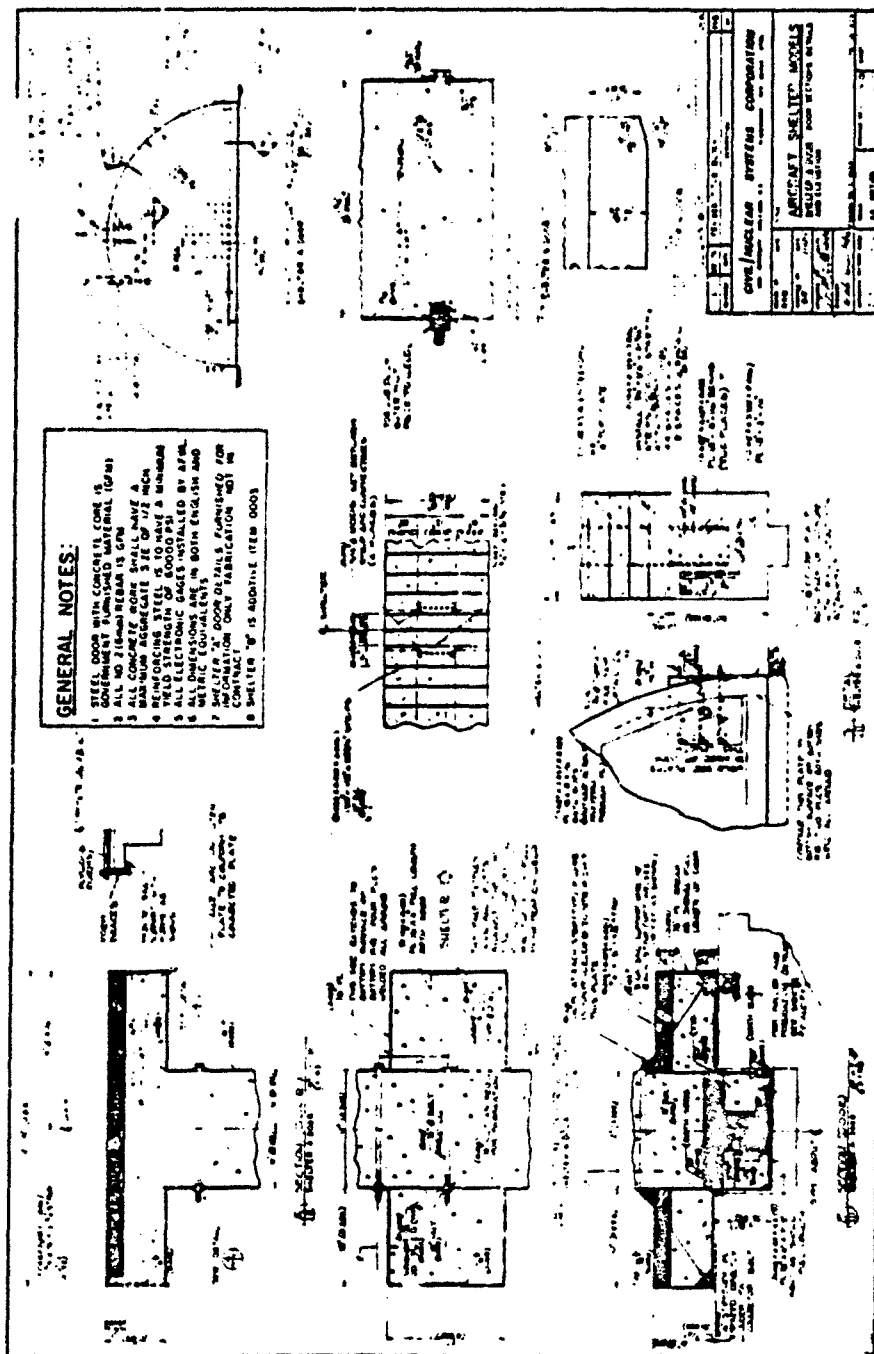
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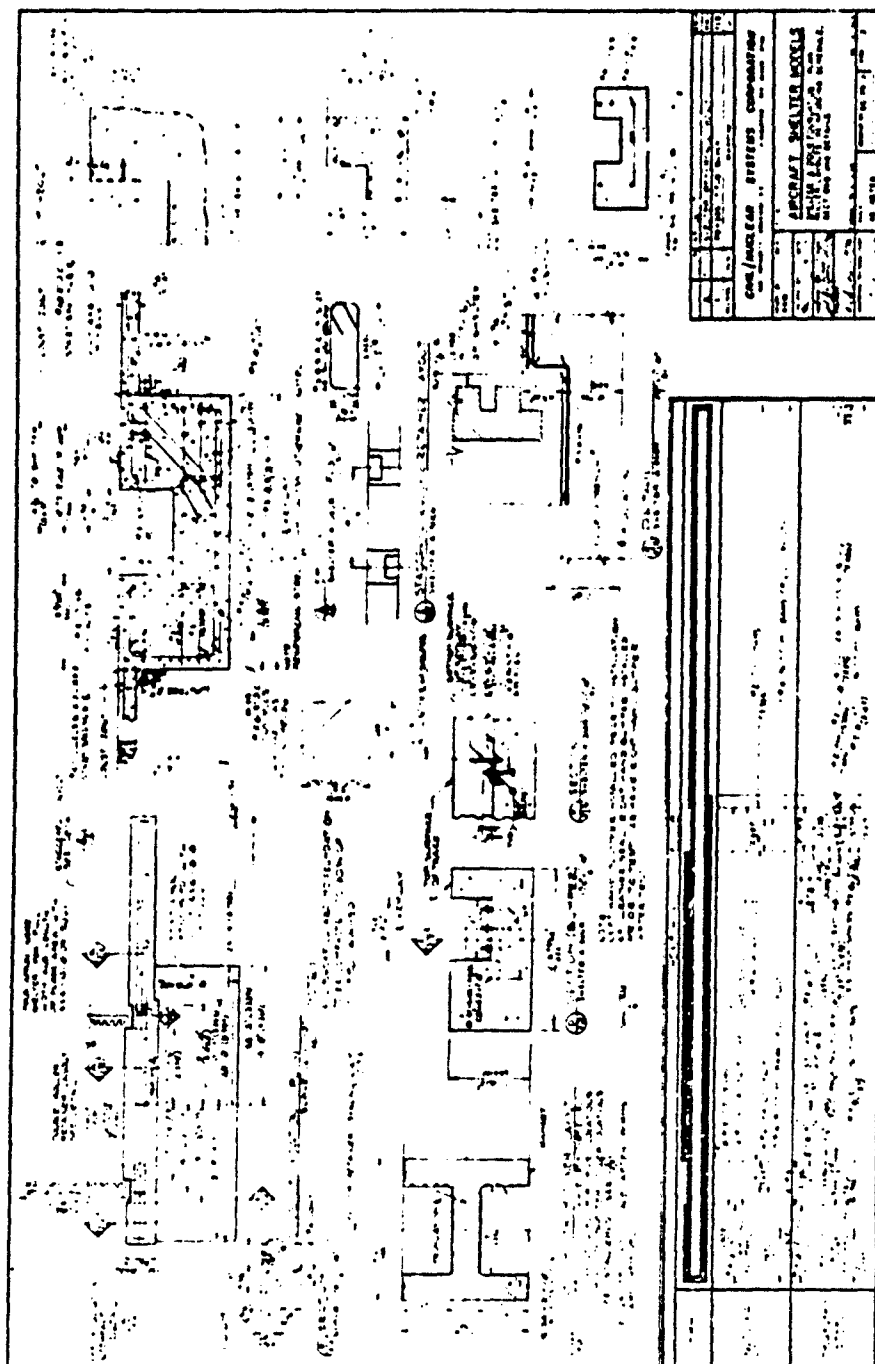
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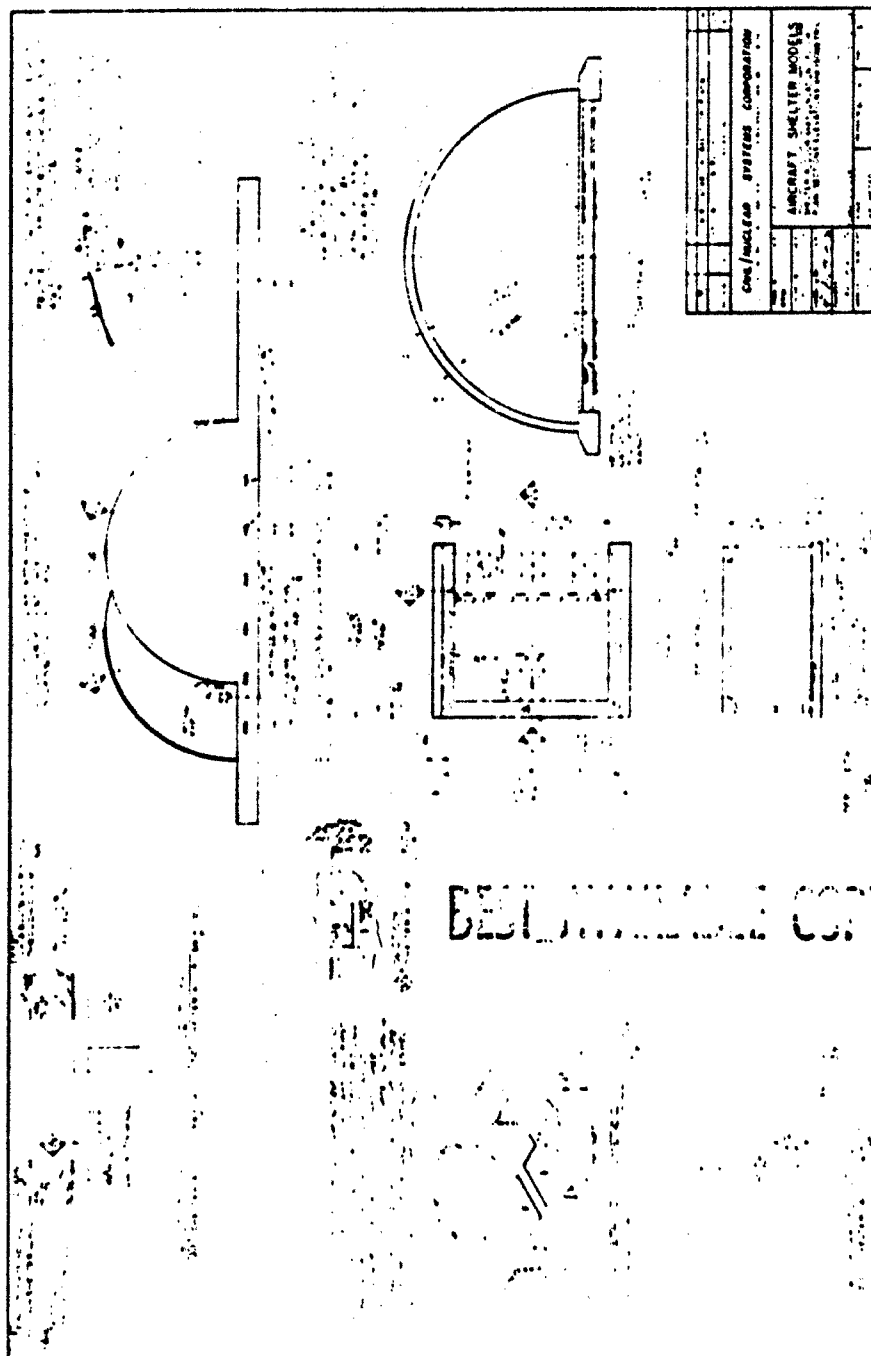
APPENDIX A  
AS-BUILT CONSTRUCTION DRAWINGS

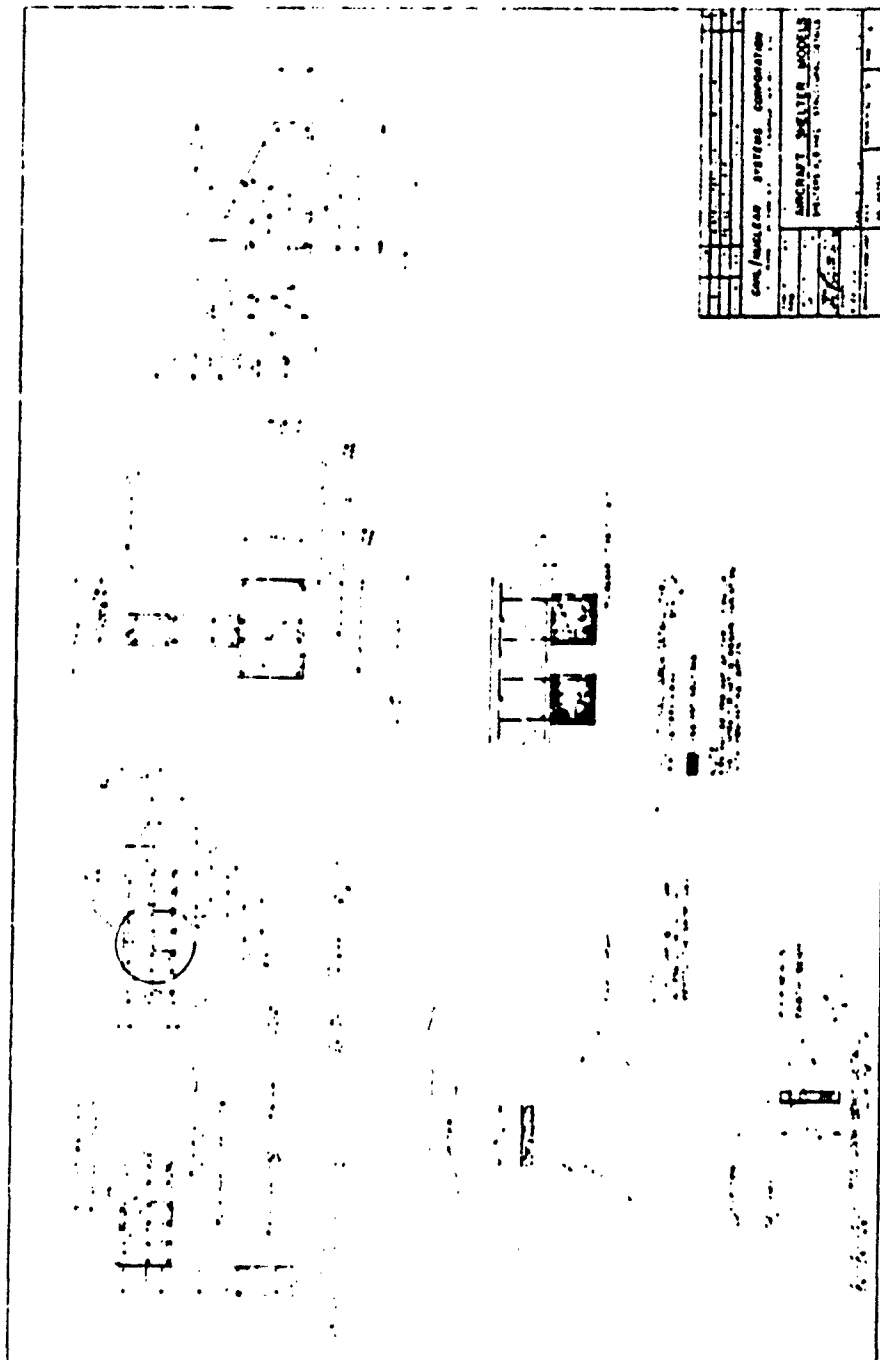


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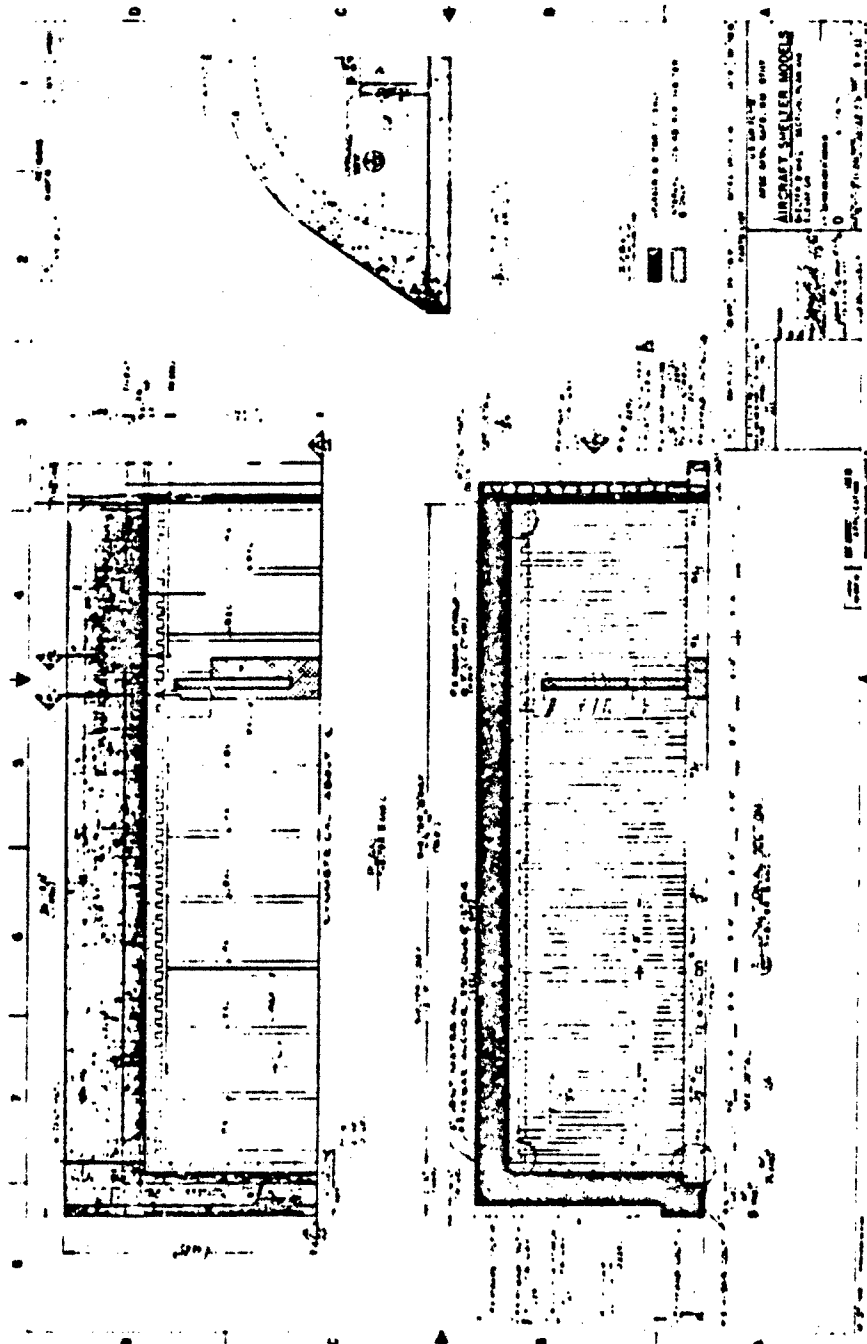




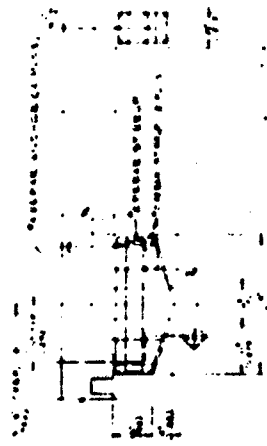




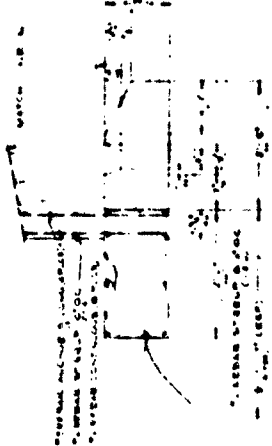
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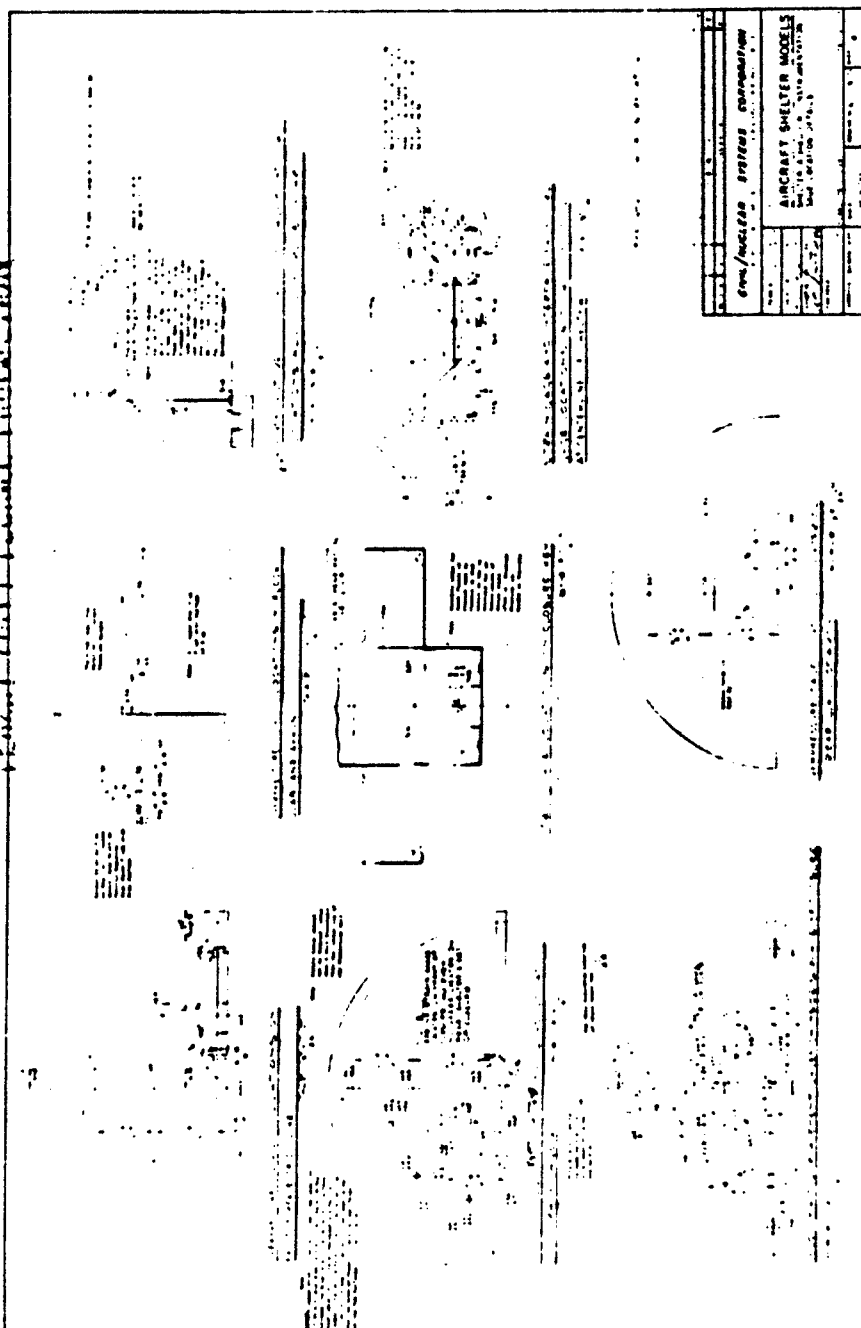


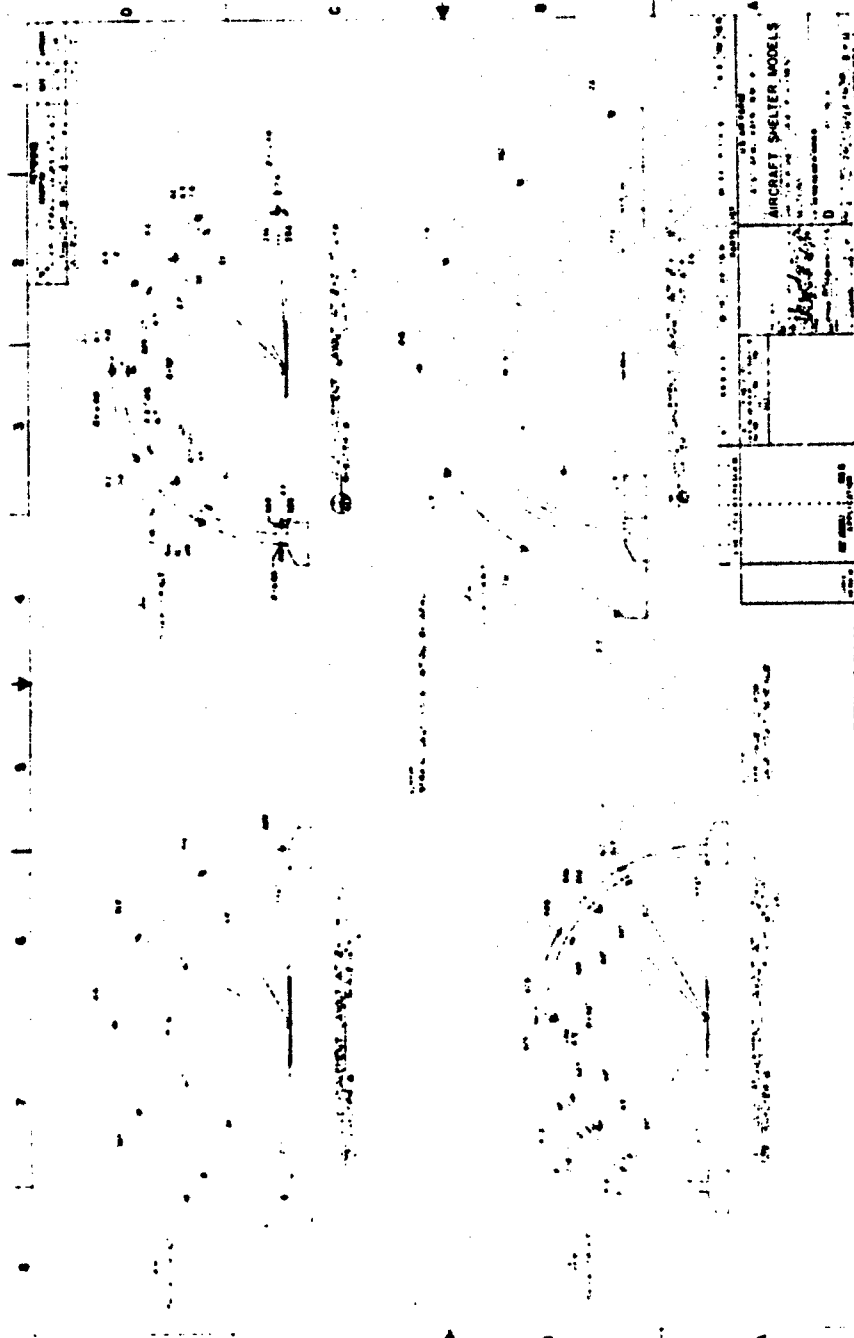
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Author	AFWL-TR-77-001
Revised	
Drawn	
Checked	
Approved	

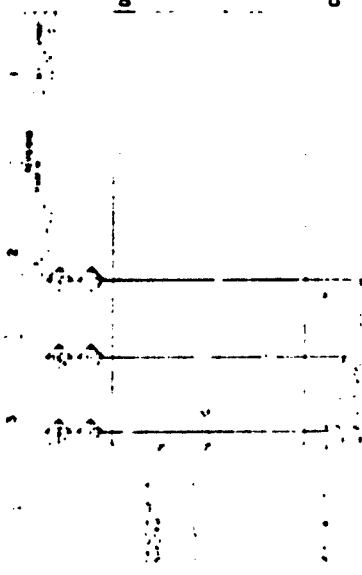
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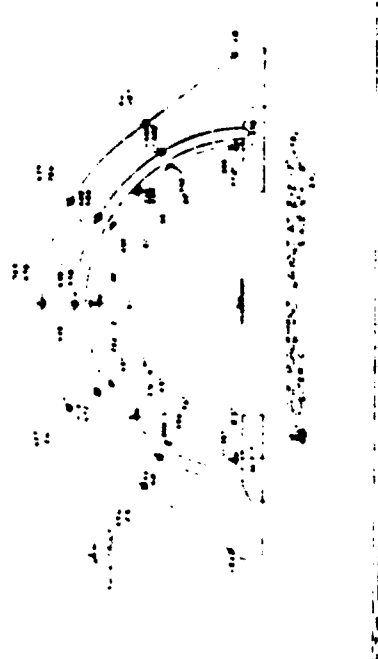
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PERMIT FULLY LEGIBLE PRODUCTION

copy



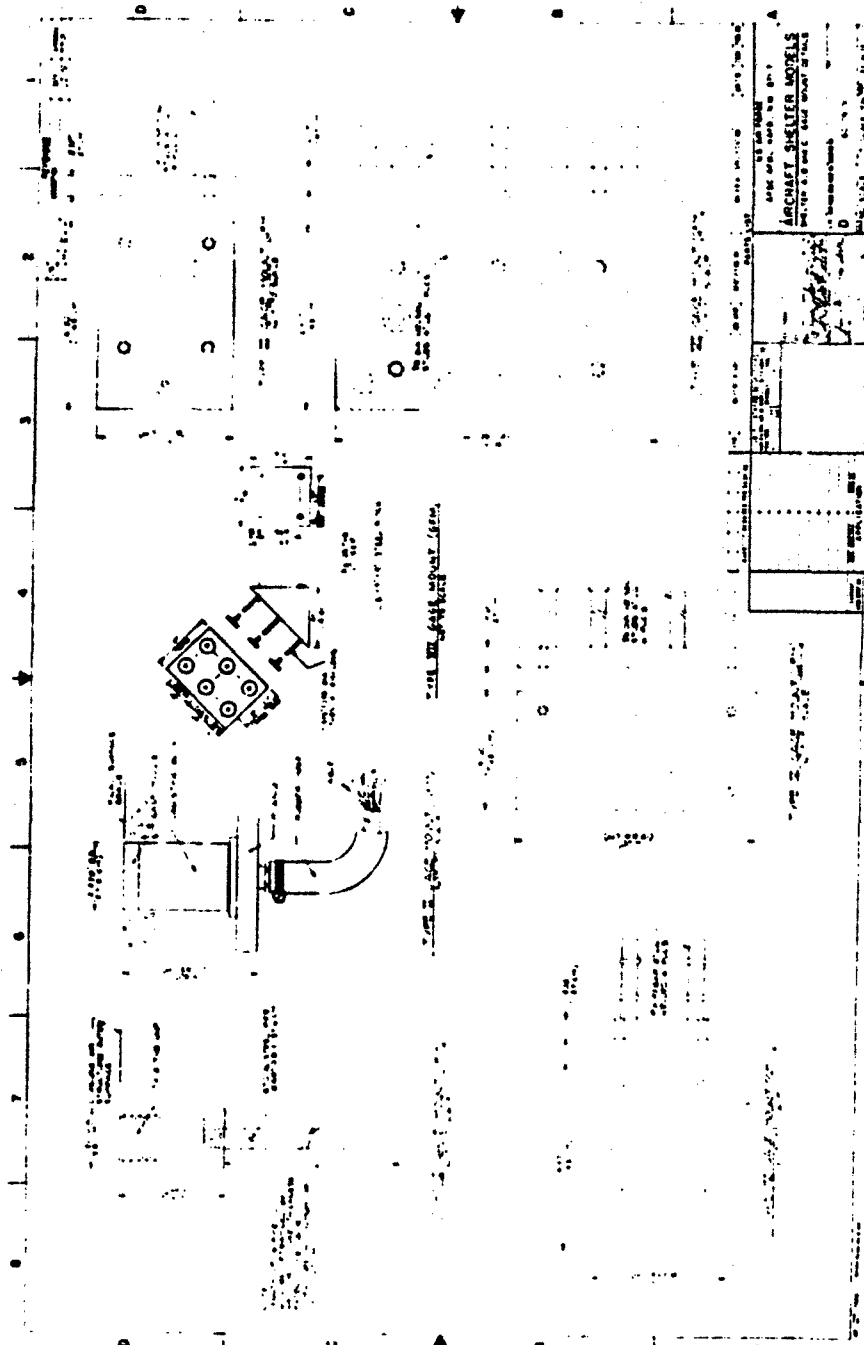
GAGE MOUNT SCHEDULE		SCHEDULE	
SCHEDULE		SCHEDULE	
1	2	3	4
5	6	7	8
9	10	11	12
13	14	15	16
17	18	19	20
21	22	23	24
25	26	27	28
29	30	31	32
33	34	35	36
37	38	39	40
41	42	43	44
45	46	47	48
49	50	51	52
53	54	55	56
57	58	59	60
61	62	63	64
65	66	67	68
69	70	71	72
73	74	75	76
77	78	79	80
81	82	83	84
85	86	87	88
89	90	91	92
93	94	95	96
97	98	99	100

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100
---	---	---	---	---	---	---	---	---	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	-----

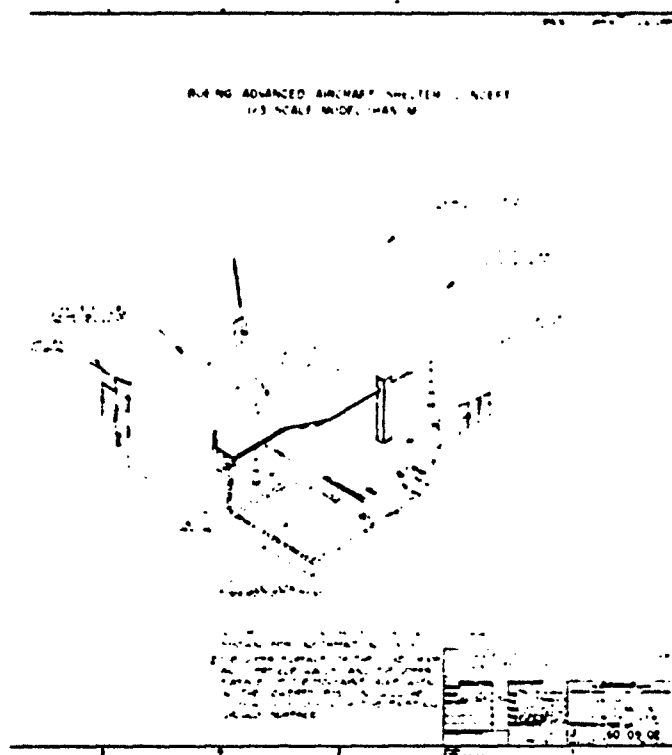




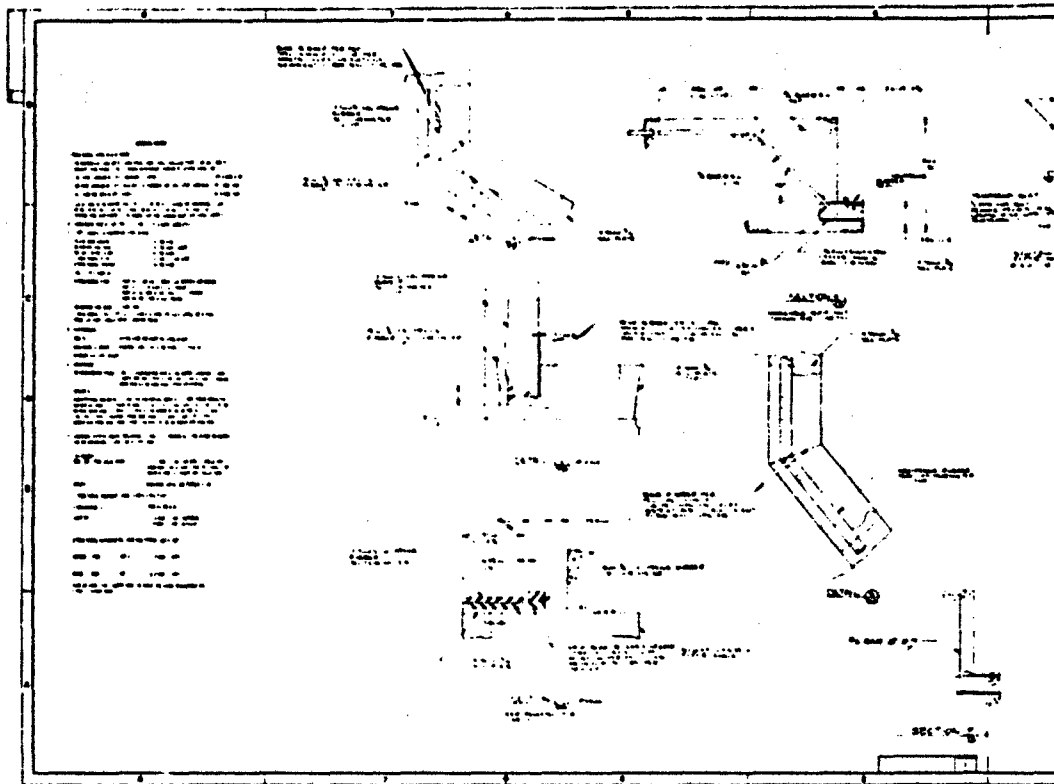
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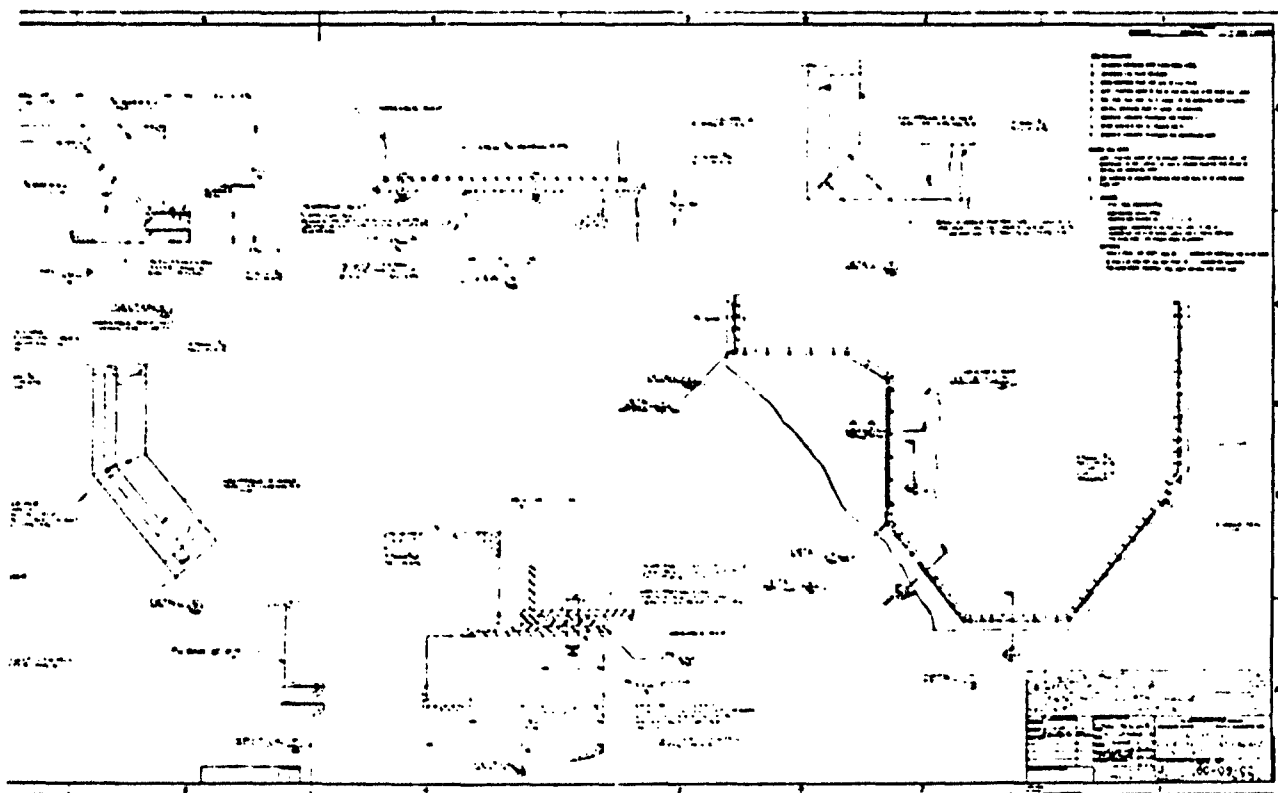
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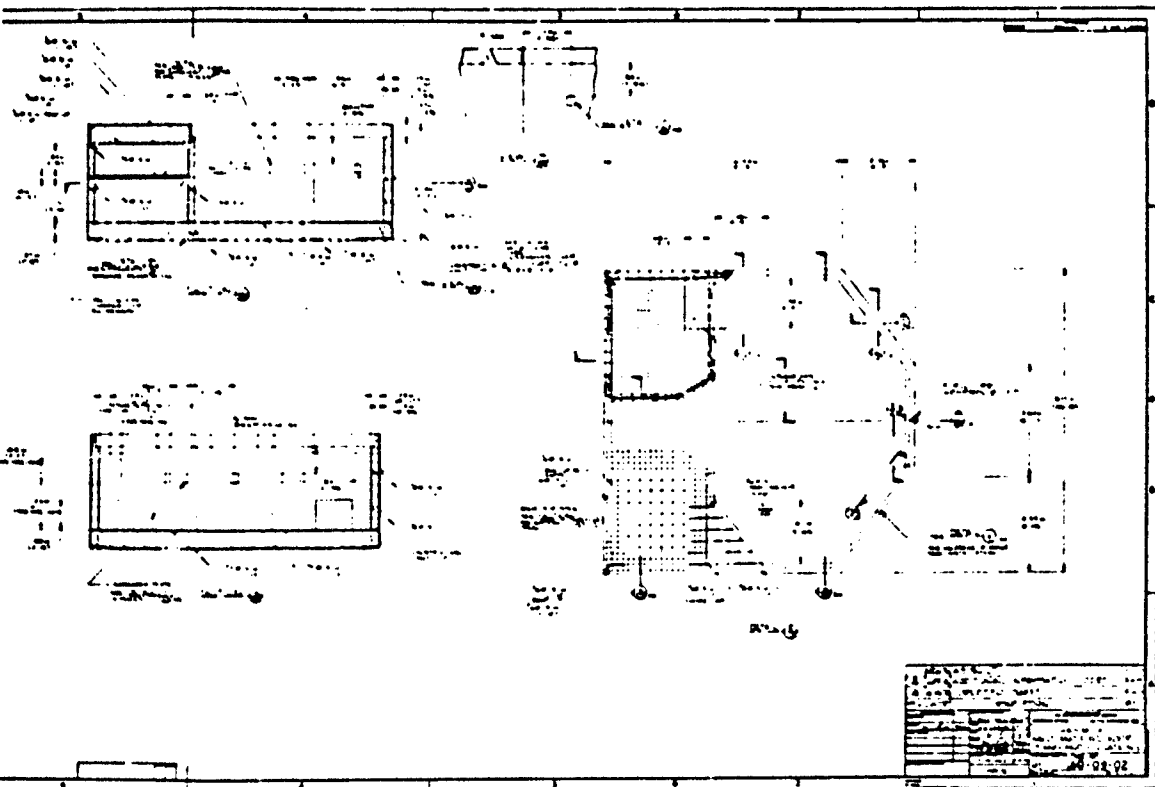
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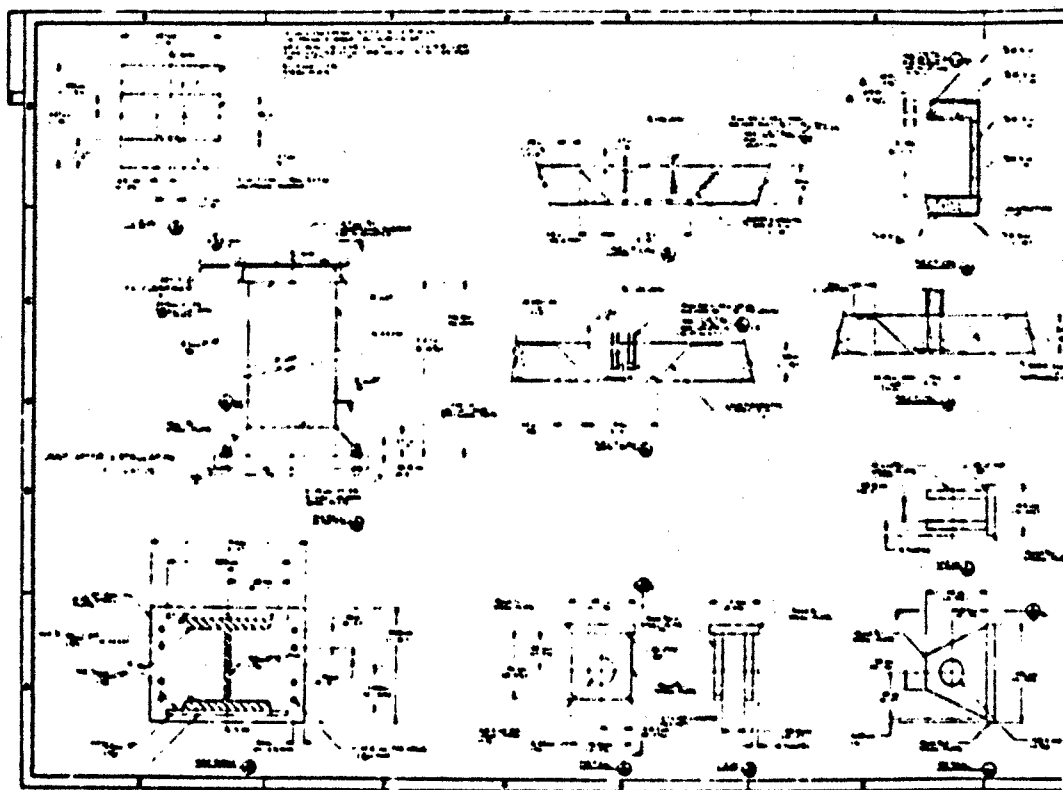
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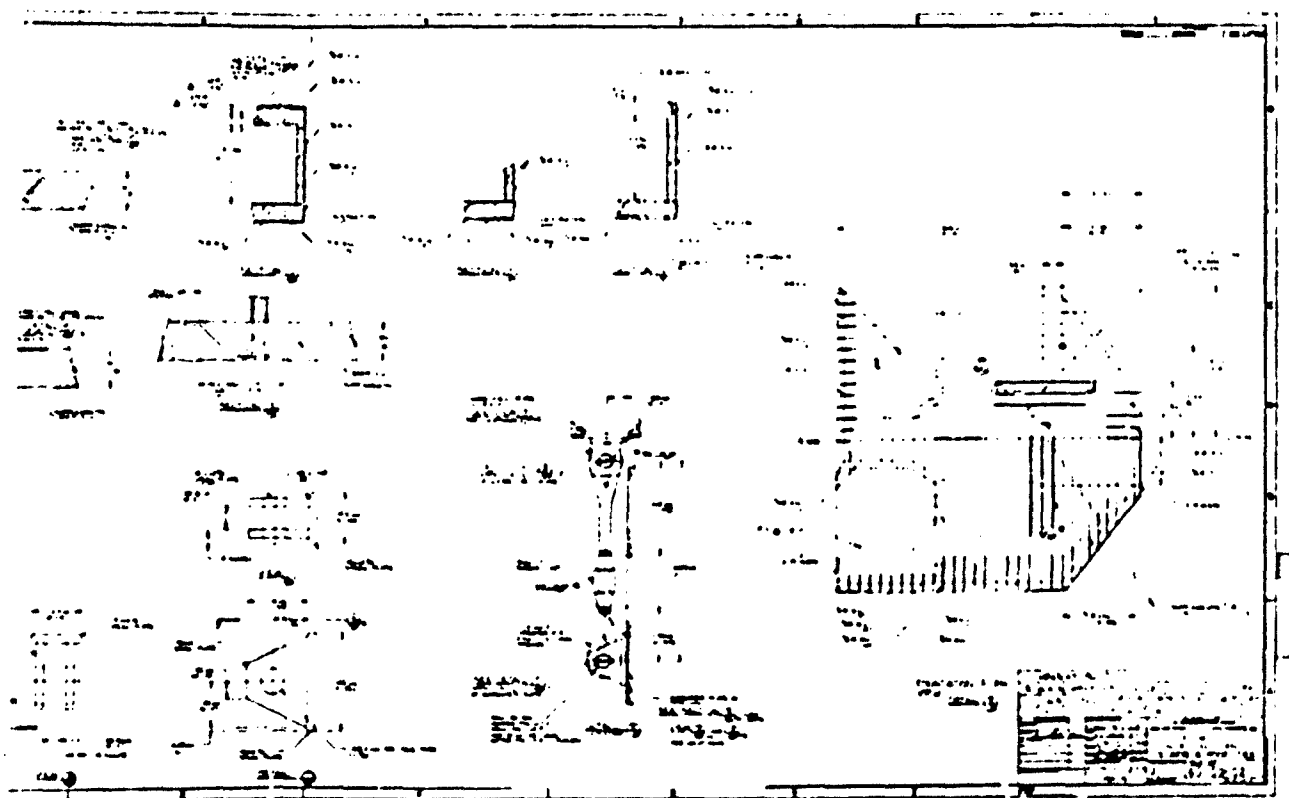


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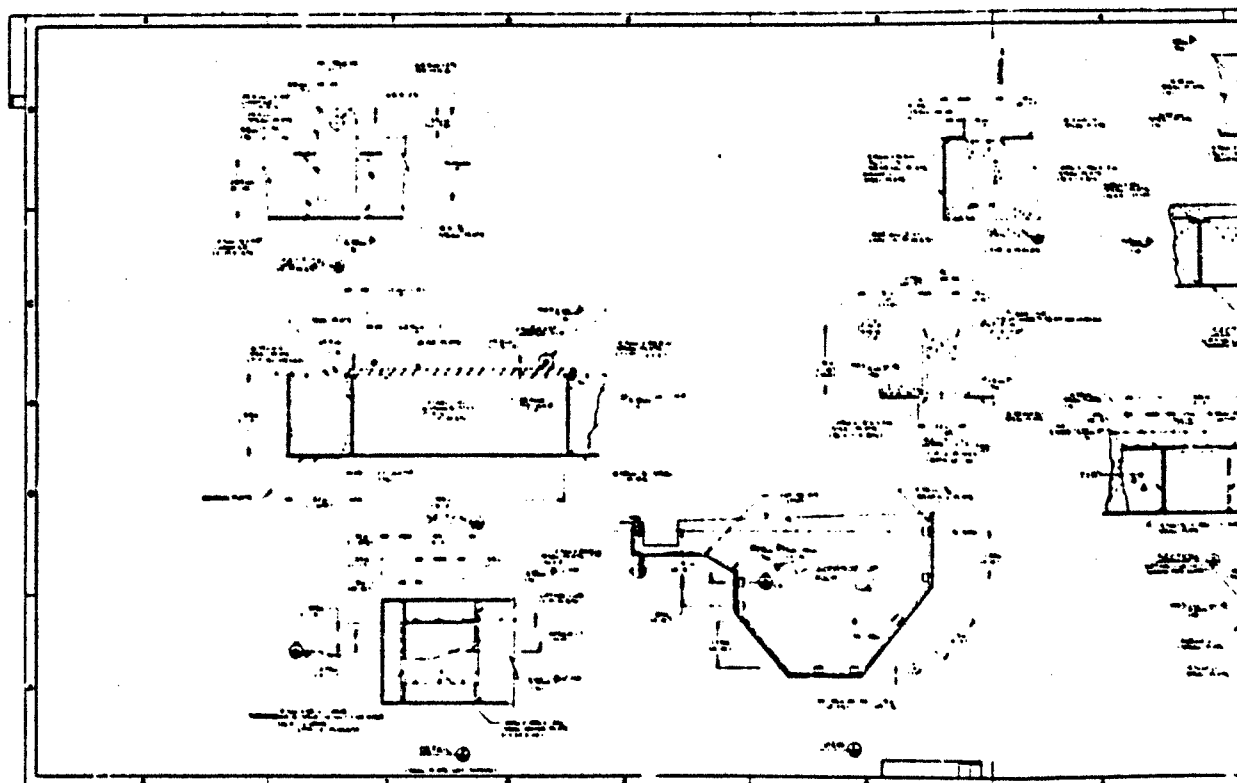
AFWL-TR-77-001



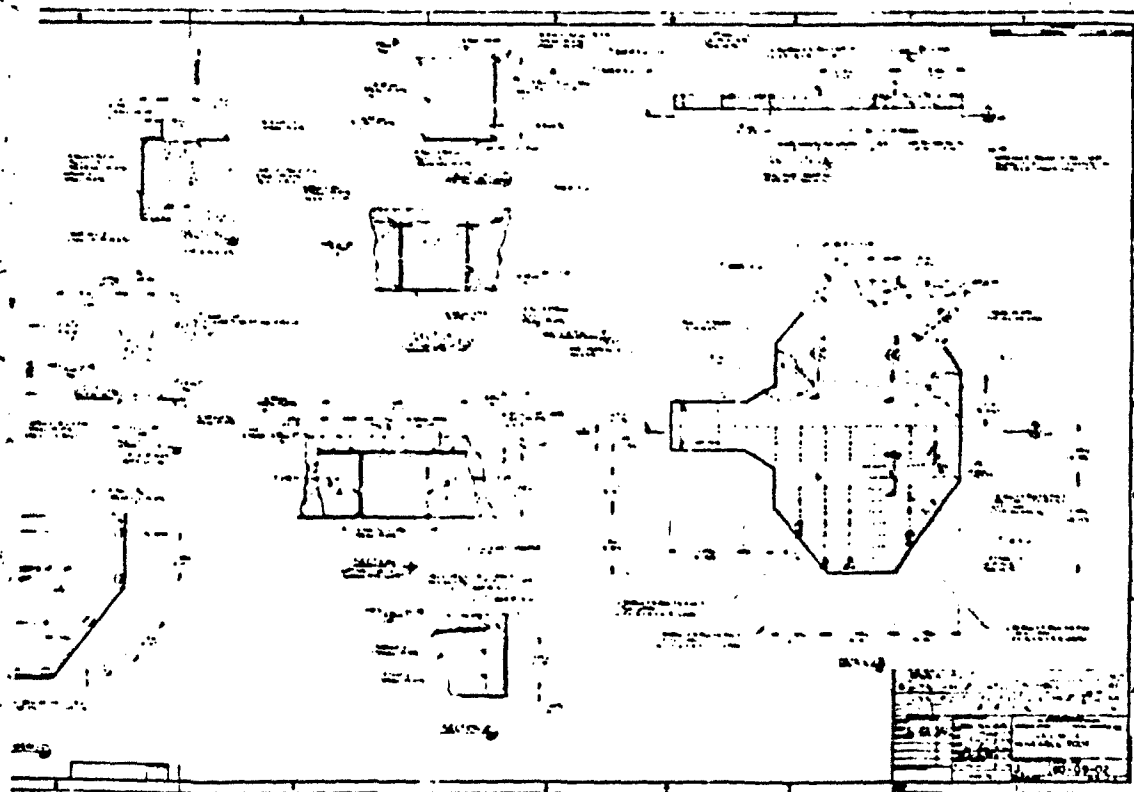




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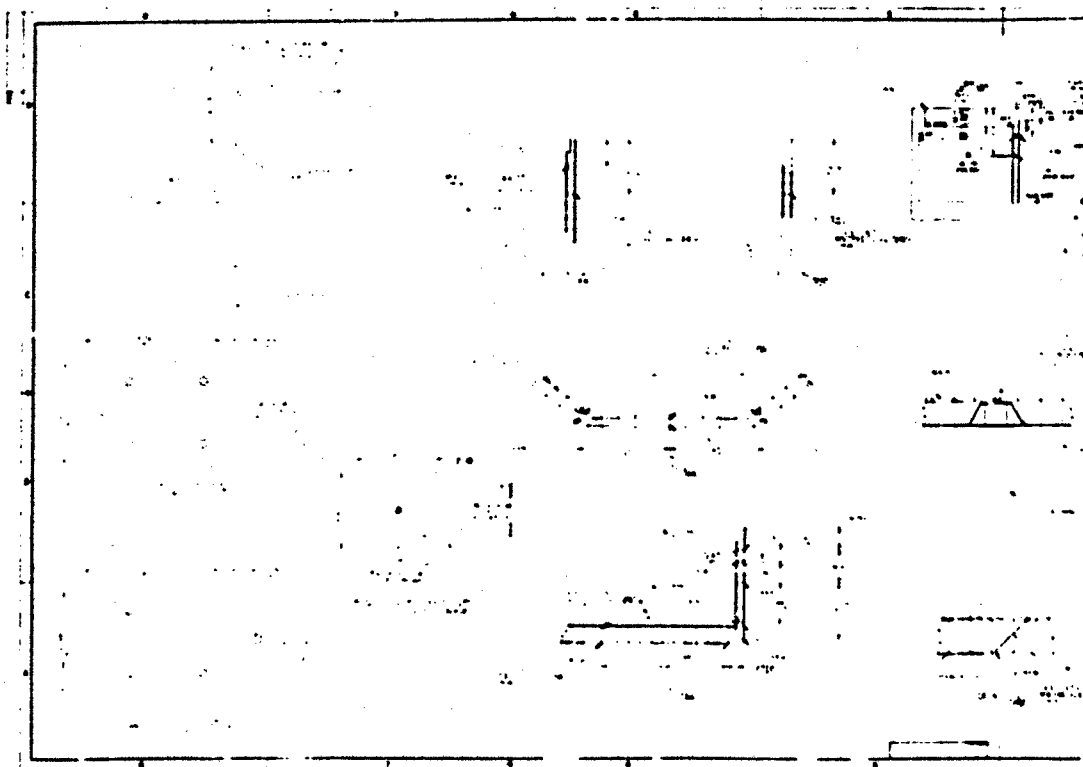
AFWL-TR-77-001



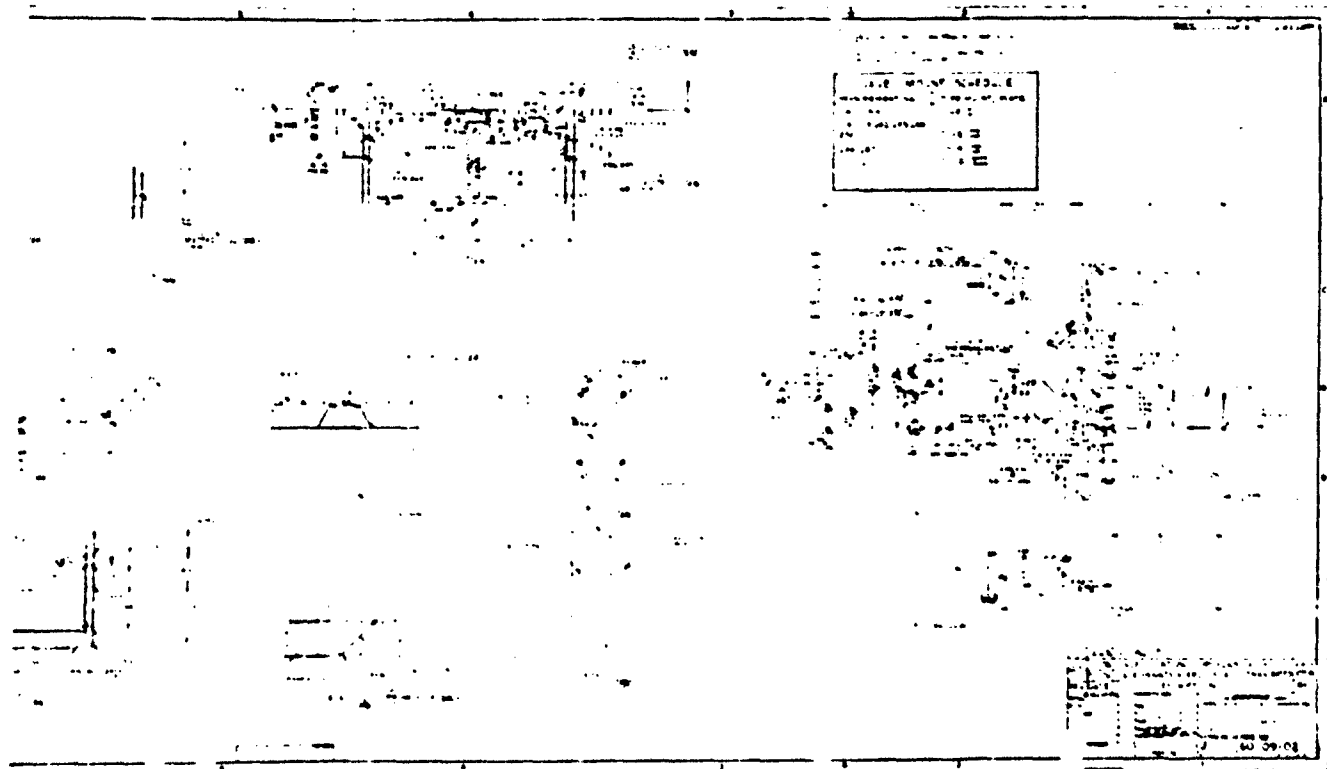
2

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## APPENDIX B INSTRUMENTATION

The instrumentation details and specifications contained in this appendix have been obtained from AFWL Technical Note DE-TN-76-003, DICE THROW Instrumentation Plan. The information contained in this appendix is not all inclusive of the information contained in the above Technical Note, which should be referenced, for further required information.

### 1. MEASURAND/POLARITY CONVENTION

The convention used in setting up transducer output polarities was as follows:

- a. Steel strains - tension is positive
- b. Blast pressure, normal interface pressure - compression positive
- c. Acceleration and velocity - motions downward, radially outward, longitudinally away from ground zero and azimuthally clockwise are positive.
- d. Relative displacement - Distance between points increase is positive.

### 2. TRANSDUCERS

The different types of transducers for each type of measurement, and specifications for those transducers are given below.

- a. Velocity Measurements. Both vertical and horizontal velocity measurements were made using the Sandia DX type velocity gages manufactured by Bell and Howell. Their specifications follow:

#### (i) Horizontal Velocity Transducer 364137

##### PERFORMANCE SPECIFICATIONS

Range:	$\pm 1$ to $\pm 500$ ft/sec ( $\pm .3$ to $\pm 150$ m/s)
Undamped Natural Frequency:	3 Hz $\pm$ 0.25 Hz

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Resolution:	Infinite
Linearity of Undampened Gauge:	0.5 % of full scale
Repeatability of Undampened Gauge:	0.5% of full scale
Hysteresis of Undampened Gauge:	$\pm 0.25\%$ of full scale
Shock Load:	500 "g" any axis (50 km/s <sup>2</sup> )

The transducer performance is not degraded by 5 half-sine acceleration pulses of .30 ms in duration and 5000 "g" (50 km/s<sup>2</sup>) magnitude. Special pivots were secured within the head assembly, when subjected to the above environment, no degradation will occur beyond the specification parameters. The E-core will remain tight and in place during the shock excursion.

Temperature Sensitivity of full range:	Less than 1.5% per °C
Output:	AC differential, compatible with carrier oscillators and amplifiers
Power Output:	1 watt maximum
Output Impedance:	(28 + j $\omega$ 0.18) ohms full bridge nominal
Excitation:	3 kHz 10V RMS
Physical Specifications:	See DOD: CED 364137
Weight:	520 grams

## (2) Vertical Velocity Transducer 364142

### PERFORMANCE SPECIFICATIONS

Range:	$\pm 1$ to $\pm 500$ ft/sec ( $\pm .3$ to $\pm 150$ m/s)
Undampened Natural Frequency:	3 Hz $\pm 0.25$ Hz
Resolution:	Infinite
Linearity of Undampened Gauge:	0.5% of full scale
Repeatability of Undampened Gauge:	0.5% of full scale
Hysteresis of Undampened Gauge:	$\pm 0.25\%$ of full scale

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Zero Adjust: Capability Provided  
Shock Load: 5000 "g" any axis ( $\sim 50 \text{ km/s}^2$ )

The transducer performance will not be degraded by 5 half-sine acceleration pulses of .30 ms in duration and 5000 "g" ( $50 \text{ km/s}^2$ ) magnitude. The special pivots are secured within the head assembly, and when subjected to the above environment, no degradation will occur beyond the specification parameters. The E-core will remain tight and in place during the shock excursion.

Temperature Sensitivity of full range:

Output: AC differential, compatible with carrier oscillators and amplifiers.  
Power Output: 1 watt maximum  
Output Impedance:  $(28 + j\omega 0.18)$  ohms full bridge nominal  
Excitation: 3kHz 10V RMS  
Physical Specifications: See DOD: CED 364142  
Weight: 520 grams

The velocity gage used a silicon fluid compound manufactured by Dow Corning, Series 210, as a damping fluid. The gage velocity range and response was changed by using damping fluids of different viscosities. The viscosities available and the corresponding approximate linear ranges are:

<u>Viscosity</u> <u>(Centistokes)</u>	<u>Approximate Linear Range</u> <u>(Ft/Sec)</u>
7000 ( $7 \times 10^{-3} \text{ m}^2/\text{s}$ )	<u>Brass Pendulum</u>
5000	
3000	200 (60 m/s)
2000	100 (30 m/s)
1000	75 (23 m/s)

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<u>Viscosity (Centistokes)</u>	<u>Approximate Linear Range (Ft/Sec)</u>
500	30 (10 m/s)
200	18 (5 m/s)

Because the damping fluid viscosity is temperature dependent, a number of thermistors were installed at velocity transducer locations. Accurate calibration of these thermistors enabled the temperatures at the velocity gage locations to be determined through measurement of the thermistor resistances. These temperature determinations were made frequently and logged.

b. Acceleration

Acceleration measurements were made on the shelter closure and shelters using the following acceleration transducers:

Endevco Model 2260C-500 MI 500 g ( $5 \text{ km/s}^2$ )

Endevco Model 2260C-250 MI 250 g ( $2.5 \text{ km/s}^2$ )

Specifications for these gages are as follows:

(1) Accelerometer, Model 2260C-500 MI.

This instrument is a general purpose, moderate range accelerometer of the piezoresistive type. It has a strain gage bridge with active arms and two fixed resistors of  $500\Omega$  each. Provision is made for shunt calibration in a 6-wire system. Its frequency range extends from static to 3500 Hz.

ENDEVCO PIEZITE Type P-9 semiconductor crystal material is used.

CHARACTERISTICS

Dynamic Range	$\pm 500 \text{ g}$
Sensitivity	0.35mV/g nominal
Combined Linearity and Hysteresis	$\pm 1\%$ maximum of reading to 500g



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Frequency Response	$\pm 5\%$ , 0 to 3500Hz, $\pm 10\%$ , 0 to 4500 Hz
Mounted Natural Frequency	18 kHz nominal
Damping	.01 of critical
Transverse Sensitivity	3% maximum in any transverse axis
Temperature Response	
Compensated Range	-65°F to +250°F
Thermal Sensitivity Shift	-6%/0/-7% at -65°F/+75°F/250°F nominal
Thermal Zero Shift	+12 mV maximum at -65°F and 250°F Reference +75°F
Zero Balance	$\pm$ mV maximum at rated excitation and 75°F

Electrical

Rated Excitation	10.00 Vdc
Resistance (room temperature)	
Input	330 $\Omega$ nominal
Output	375 $\Omega$ nominal
Internal Fixed Resistors	500 $\pm 1\%$
Connector	has integral 6 conductor cable with shield and jacket
Insulation Resistance	greater than 100 $\Omega$ M at 100 Vdc, all leads to case
Warmup Time	1 minute

Physical

Dimensions	1.0" x .61 diameter, 5/8" hex base
Weight	1.0 oz.
Material	Type 416 stainless steel
Finish	Mirror polish
Mounting	Provision for 10-32 x 1/8" stud
Marking	Manufacturer's name; Model number - Range; Serial Number

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Environmental

Temperature Range

Operating -65°F to +250°F

Non-Operating -100°F to +300°F

Humidity Epoxy sealed

Acceleration Limits (any direction)

Static ±1500 g

Sinusoidal ±1000g at frequencies below 3500 Hz

Shock ±1500g half sine pulse, 300μ sec or longer  
duration

ACCESSORIES

Instructional Manual

Calibration Card

Stud 2981-3

Shipping Box

CALIBRATION SUPPLIED

Sensitivity

Input Impedance

Output Impedance

Maximum Transverse Sensitivity

Mounted Resonance Frequency

Zero Measurand Output

(2) Accelerometer Model 2260C-250M1

This instrument is a general purpose, moderate range accelerometer of the piezoresistive type. It has a strain gage bridge with two active arms and two fixed resistors of 500. each. Provision is made for shunt calibration in a 6-wire system. Its frequency range extends from static to 2500 Hz.

ENVELOPE PIEZITE Type P-9 semiconductor crystal material is used.

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## CHARACTERISTICS

Dynamic Range	$\pm 250g$
Sensitivity	0.7 mV/g nominal
Combined Linearity and Hysteresis	$\pm 1\%$ maximum of reading to 250g
Frequency Response	$\pm 5\%$ , 0 to 2500 Hz, $\pm 10\%$ , 0 to 3000 Hz
Mounted Natural Frequency	14 kHz nominal
Damping	.01 of critical
Transverse Sensitivity	3% maximum in any transverse axis
Temperature Response	
Compensated Range	-65°F to +250°F
Thermal Sensitivity Shift	-6 / 0 / -7 at -65°F / +75° / 250°F nominal
Thermal Zero Shift	$\pm 12$ mV maximum at -65°F and +250°F; Reference +75°F
Zero Balance	$\pm$ mV maximum at rated excitation and 75°F

## Electrical

Rated Excitation	10.00 Vdc
Resistance (room temperature)	
Input	330 $\Omega$ nominal
Output	375 $\Omega$ nominal
Internal Fixed Resistors	500 $\Omega$ $\pm 1\%$
Cable	Has integral 6 conductor cable with shield and jacket.
Insulation Resistance	Greater than 100M at 100 Vdc, all leads to case.
Warmup Time	1 minute

## Physical

Dimensions	1.0" x .61" diameter, $\pm .01$ " max base
------------	--

## SPECIFICATIONS FOR PRESSURE TRANSDUCERS

	HTS-3-375-500	HTS-1-190-200	HTS-1-190-160	HTS-1-190-25
Pressure				
Rated (psi)	500 (3.5 MPa)	200 (1.4 MPa)	100 (690 kPa)	25 (170 kPa)
Maximum (psi)	750 (5.2 MPa)	400 (2.8 MPa)	200 (1.4 MPa)	50 (350 kPa)
Output-nominal (mV)	125	100	100	75 mV
Acceleration Sensitivity				
Longitudinal (% FS/g)	.0001	.00011	.0002	.002
Transverse (% FS/g)	.00002	.000046	.00004	.00004
Natural Frequency (kHz)	350	200	160	50
Bridg. Type	Fully active four arm Wheatstone bridge diffused into silicon diaphragm			
Operating Temperature	5V DC or AC	7.5-10V DC or AC	7.5-10V DC or AC	5-20V DC or AC
Bridge Impedance	350 ohms nom.	500 ohms nom.	500 ohms nom.	500 ohms nom.
Linearity	$\pm 1\%$ FS	$\pm 1\%$ FS	$\pm 1\%$ FS	$\pm 1\%$ FS
Combined Non-Linearity and Hysteresis	$\pm 1\%$ FS	$\pm 0.5\%$ FS	$\pm 0.5\%$ FS	$\pm 1\%$ FS
Repeatability	0.25%	.25%	.25%	$\pm 0.25\%$
Operating Temperature	-55°F to +300°F (-55°C to 150°C)	0°F to 250°F (-20°C to 80°C)	0°F to 250°F (-20°C to 80°C)	0°F to 250°F (-20°C to 120°C)
Change of Sensitivity with Temperature	$\pm 5\%/100^\circ\text{F}$	$\pm 2.5\%/100^\circ\text{F}$	$\pm 2.5\%/100^\circ\text{F}$	$\pm 2\%/100^\circ\text{F}$
Resolution	Infinite	Infinite	Infinite	Infinite

# STRAIN GAGE SPECIFICATIONS

	Model CEA-06-062uw-350	Model CEA-06-125-uw-350
Resistance in ohms	350 $\pm$ .3%	350 $\pm$ .3%
Gage length	1.57mm	3.18mm
Overall length	5.59mm	8.26mm
Grid width	3.05mm	4.57mm
Overall width	3.05mm	4.57mm

The gages feature large integral copper solder tabs and a completely encapsulated grid. The CEA gage series is a general-purpose strain gage. The constantan grids are completely encapsulated in polyimide, with large, integral, copper-coated terminals. This gage is primarily used for general purpose static and dynamic stress analysis.

## Temperature

Range: -100°F to +400°F (-75°C to +205°C)

Strain Range:  $\pm 3\%$  for gage lengths under 1/8" (3.2 mm).  $\pm 5\%$  for 1/8" and over.

## Fatigue Life:

Strain level in

Microstrain:  $\pm 1500$

Number of cycles:  $10^7$

The gage is self-temperature - compensated.

APPENDIX C  
PHOTOGRAPHIC DOCUMENTATION

All high speed camera and technical motion picture documentation of the closure during the test event were lost because of a switch being inadvertently activated prior to the test event. However, for information purposes the locations and perspectives of the cameras are presented in this appendix. Photographs of the camera placement and targets are contained in Figures C-1 through C-5.

1. Shelter A

Six cameras were to be utilized on this shelter. Two outside cameras were to document the gross response of the closure, concentrating on the door/shelter interface. Four cameras positioned inside the shelter were to record: (a) the movement of the closure, especially the rebound behavior, (b) the relative displacement of the arch crown to the footings, and (c) the interface characteristics of the arch and interior door support collar. The locations of the cameras relative to the structure are shown in Figures C-1, C-2, & C-4.

The two outside cameras were high speed (1000 fps); the inside cameras were 400 fps.

2. Shelter B

One camera was placed inside the shelter to observe the relative displacement of the arch crown to the footings. This camera was located on the shelter floor near the rear wall looking forward toward the front of the arch. The shelter ceiling and much of the sidewalls near the mid-shelter length were in the field of view. This camera had a depth of focus such that the interface between the arch and the interior door support were to be clearly visible. The camera used in this shelter was a 40' fps camera.

3. Shelter c

Shelter "C" was to have the same photographic coverage as Shelter B.

4. Shelter D

Four cameras were to be used in this shelter to record motion of the shelter roof. These cameras were located as shown in Figures C-3 and C-5. Motion of the roof was to be recorded through observation of relative motion between moving and stationary (reference) targets. As shown in Figures C-3 and C-5, targets were fabricated from steel pipe and welded to imbedded steel plates in the shelter roof or floor. All cameras in this shelter were high speed (1000 fps) cameras.

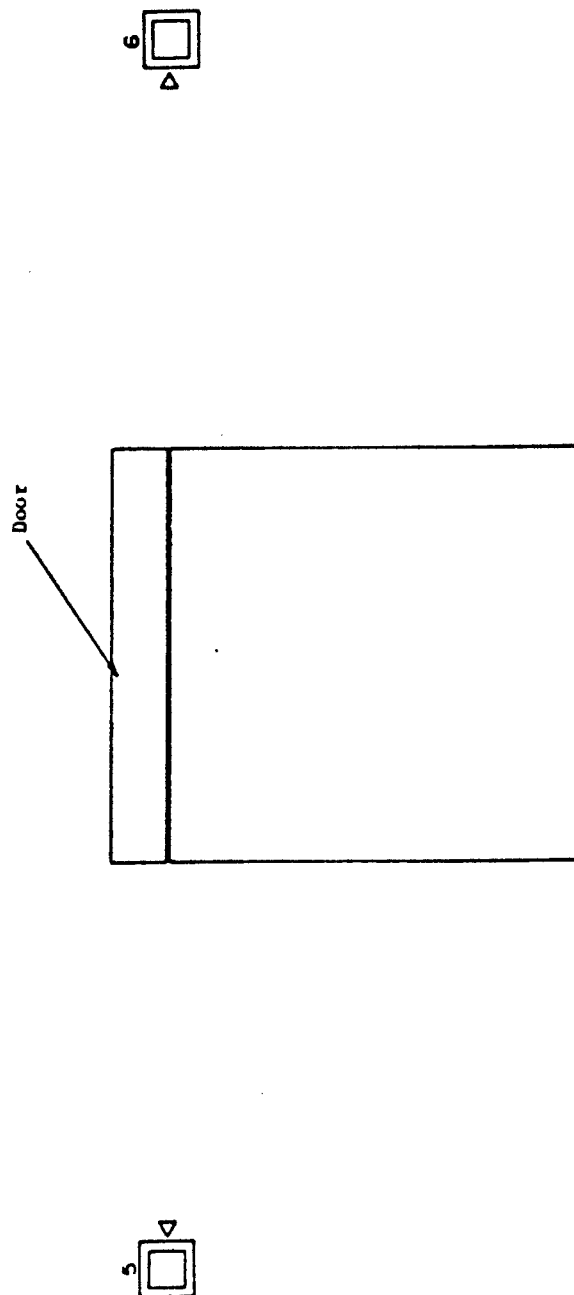


Figure C-1 Shelter A Location Of Camera No. 5 and No. 6 Outside  
of Shelter Viewing Door/Shelter Interface



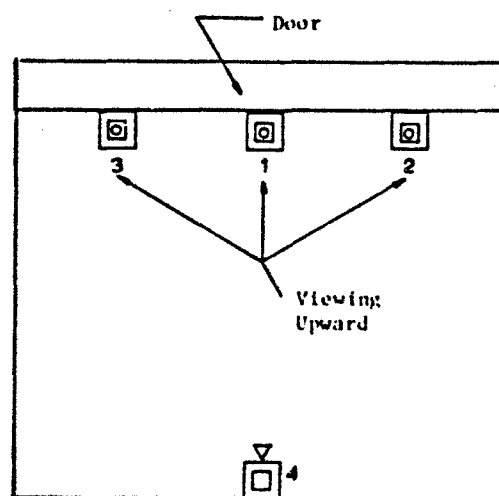


Figure C-2 Shelter "A" Camera Locations, Top View (Internal)

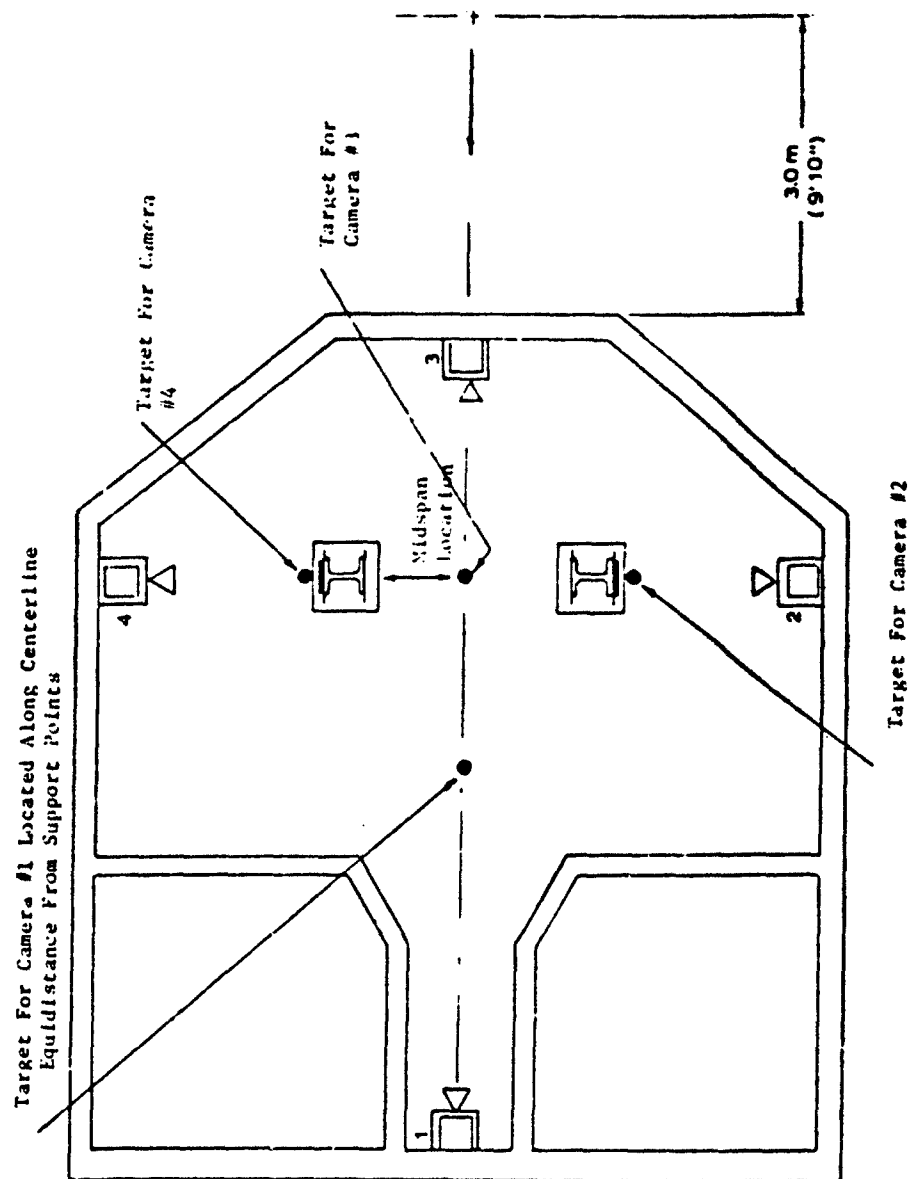
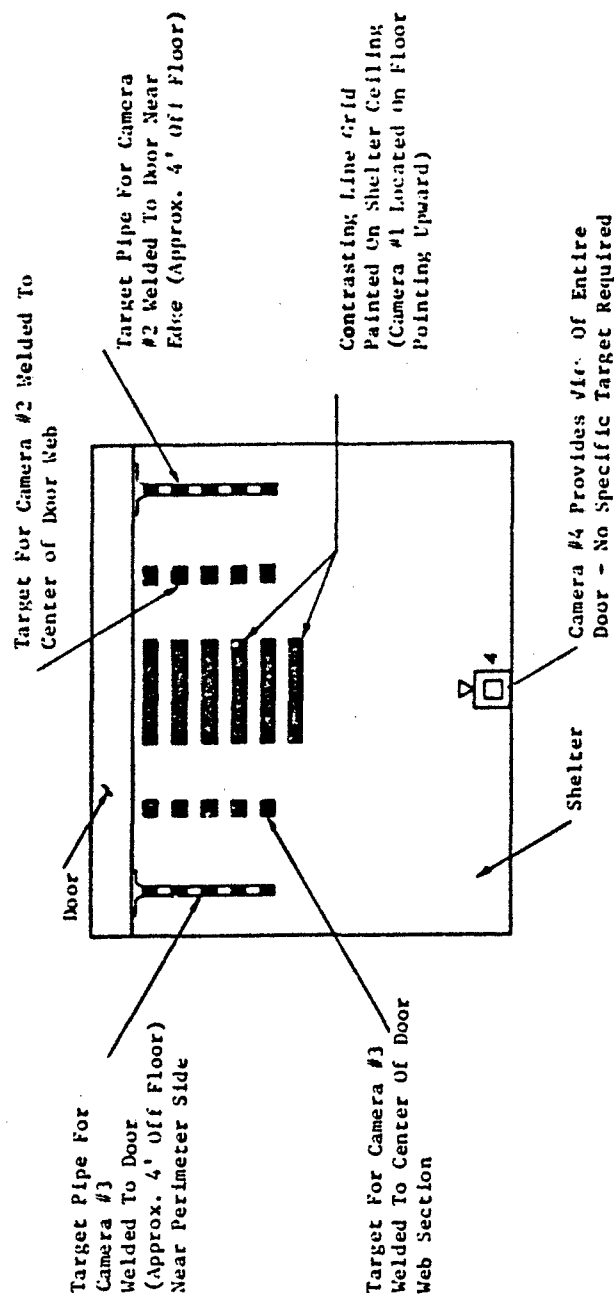


Figure C-3 Shelter "D" Locations Of Camera Nos. 1, 2, 3, and 4



GENERAL NOTE: If Cameras 2 & 3 mounted on sidewalls opposite targets, adjust target heights to avoid interference. If cameras mounted on sidewalls, use grid printed on sidewall as stationary reference OR vertical pipe welded to plate imbedded in floor. (Cameras 2 & 3 could also be mounted on floor looking up).

Figure C-4 Shelter "A" Location Of Targets, Top View (Internal)

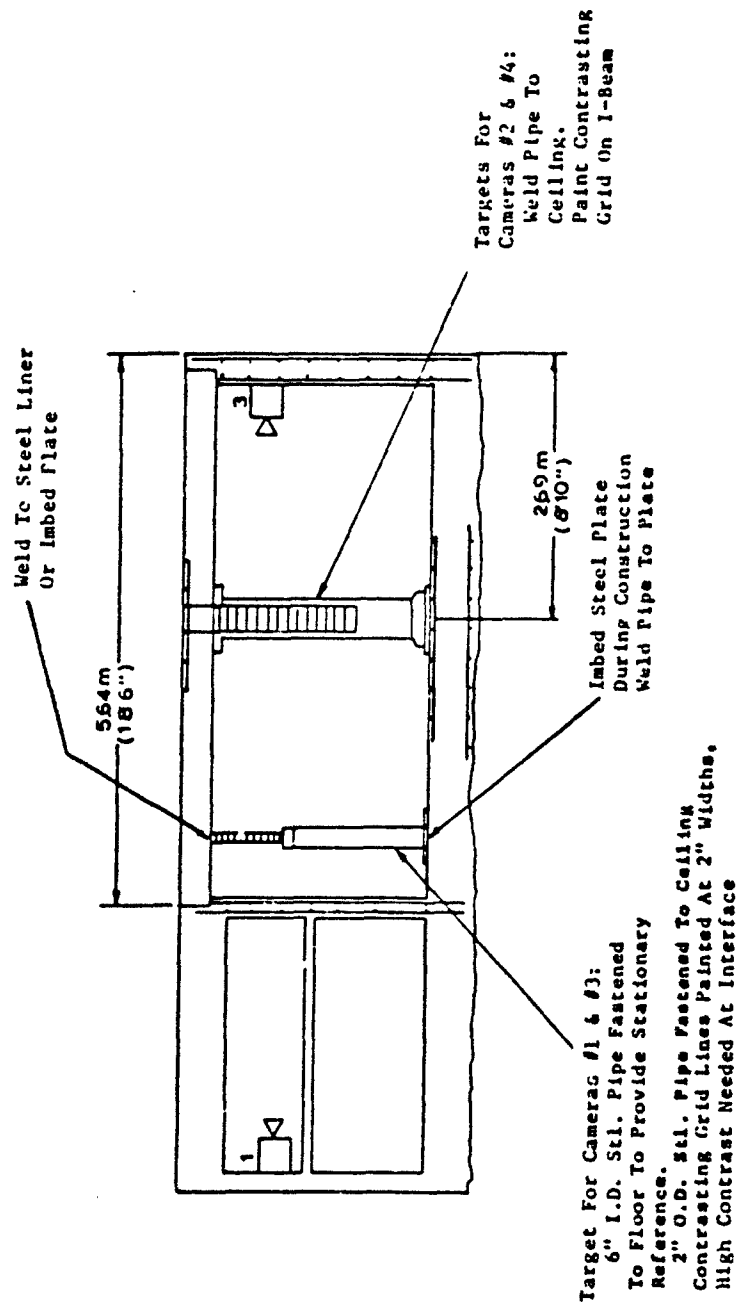


Figure C-5 Shelter "D" Location Of Target Cameras #2 and #3, Side View

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APPENDIX D  
AIRCRAFT SHELTER "A" DATA PRESENTATION

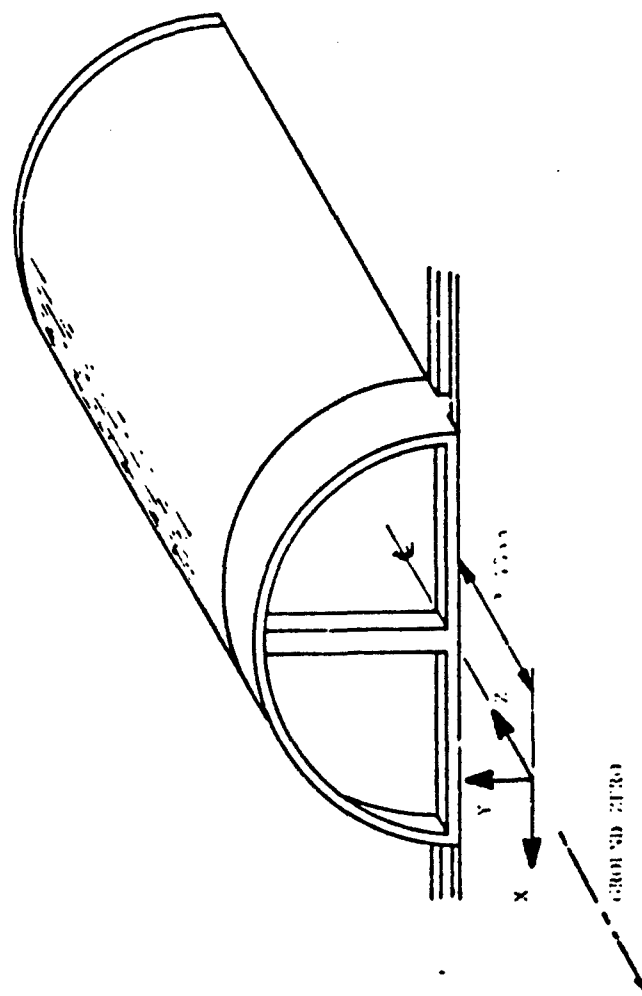


Figure D-3 Aircraft Section "A" Coordinate System

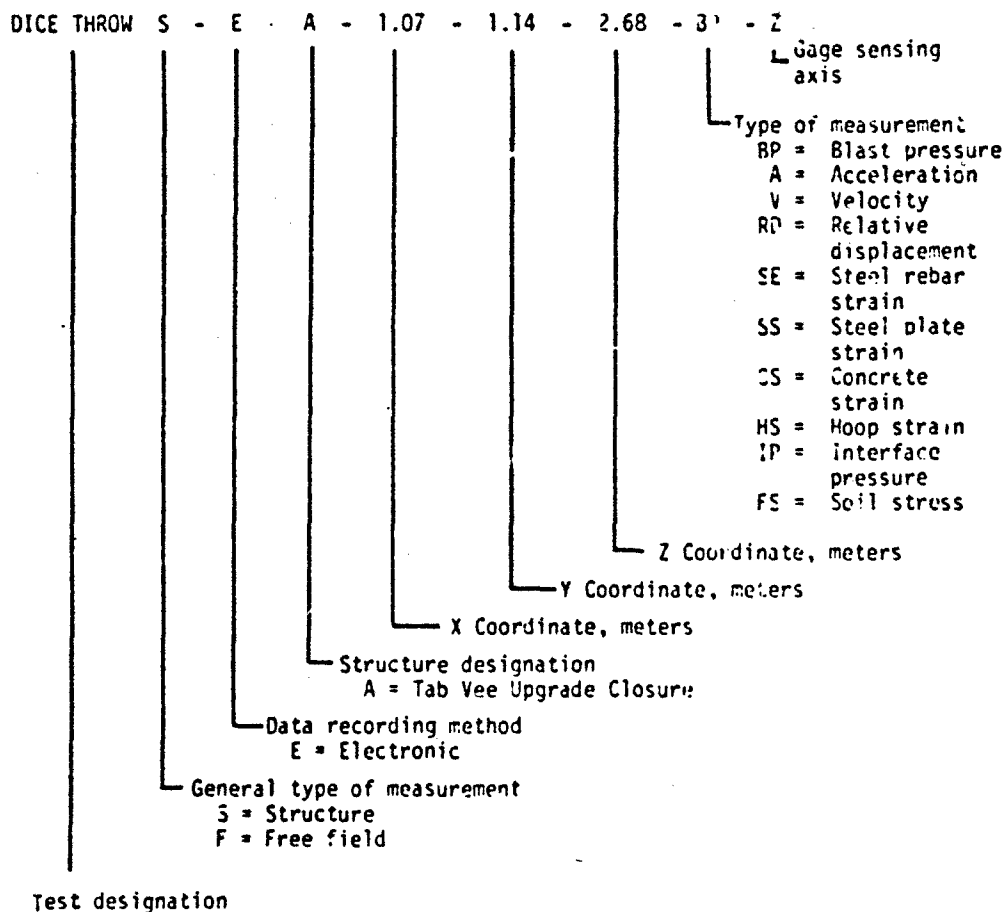


Figure D2. Measurement Designation System

#### DATA CORRECTIONS

DSP - points have been despiked.

SMT - a modified hanning smooth has been performed.

FIL - a frequency cut-off or a band reject digital filter has been made.

BLC - the data has been baseline corrected.

INV - the polarity has been reversed.

On each page, the corrected plot is at the top and the uncorrected plot is at the bottom. Each acceleration plot is followed by its integral.



## DICE THROW, SHELTER A DATA CORRECTIONS

## COORDINATES

MEAS. NO.	X METERS	Y METERS	Z METERS	TYPE	AXIS	DATA CORRECTIONS	GENERAL LOCATIONS
029	-1.96	.99	2.69	BP	Z	DSP, SMT, BLC	Ext Surf Closure
030	-1.30	2.06	2.69	BP	Z	DSP, SMT, BLC	Ext Surf Closure
031	-1.30	.23	2.69	BP	Z	DSP, SMT, BLC	Ext Surf Closure
032	-1.98	.23	2.69	BP	Z	DSP, SMT	Ext Surf Closure
033	0	2.06	2.44	BP	Z	DSP, SMT	Ext Surf Closure
034	0	1.14	2.44	BP	Z	DSP, SMT, BLC	Ext Surf Closure
035	1.07	1.14	2.69	BP	Z	DSP, SMT, BLC	Ext Surf Closure
036	0	0	1.22	BP	Z	DSP, SMT, BLC	Ext Surf Closure
037	0	0	0	BP	Z	DSP, BLC	Top and Rear
038	1.22	0	1.22	BP	Z	DSP, SMT	Top and Rear
039	0	2.74	5.74	BP	Z	DSP, SMT	Middle and Top
040	0	2.13	6.33	BP	Z	DSP, SMT	Ext Rear Wall
041	0	1.22	8.33	BP	Z	DSP, SMT	Ext Rear Wall
042	1.22	1.22	8.33	BP	Z	Covered with Soil	Ext Rear Wall
043	0	2.59	3.302	BP	Z	DSP, SMT, BLC	Ext Rear Wall
044	0	0	4.47	BP	Z	Scratched	Middle on Floor
045	0	0	4.47	BP	Z	DSP, SMT, FIL	Middle on Floor
046	0	0	6.908	BP	Z	DSP, SMT	Middle on Floor
101	0	.18	3.25	A	Z	DSP, SMT	Inner Surf of Closure
102	-1.14	1.14	3.00	A	Z	DSP, SMT, BLC	Inner Surf of Closure
103	0	1.02	3.25	A	Z	DSP, SMT	Inner Surf of Closure
104	.99	1.29	3.00	A	Z	DSP, SMT	Inner Surf of Closure
225	0	1.97	3.25	V	Z	DSP, SMT, INV	Top of Closure
226	-1.14	1.14	3.00	V	Z	DSP, SMT, INV	Inside of Closure
227	0	1.02	3.25	V	Z	DSP, BLC, INV	Inside of Closure
228	.99	1.29	3.00	V	Z	DSP, BLC, INV	Inside of Closure
229	-.68	.68	3.00	V	Z	DSP, BLC, INV	Inside of Closure
230	-.68	.80	3.00	V	Z	DSP, BLC, INV	Inside of Closure
231	0	2.66	5.68	V	Z	DSP, SMT	Middle Inside on Top

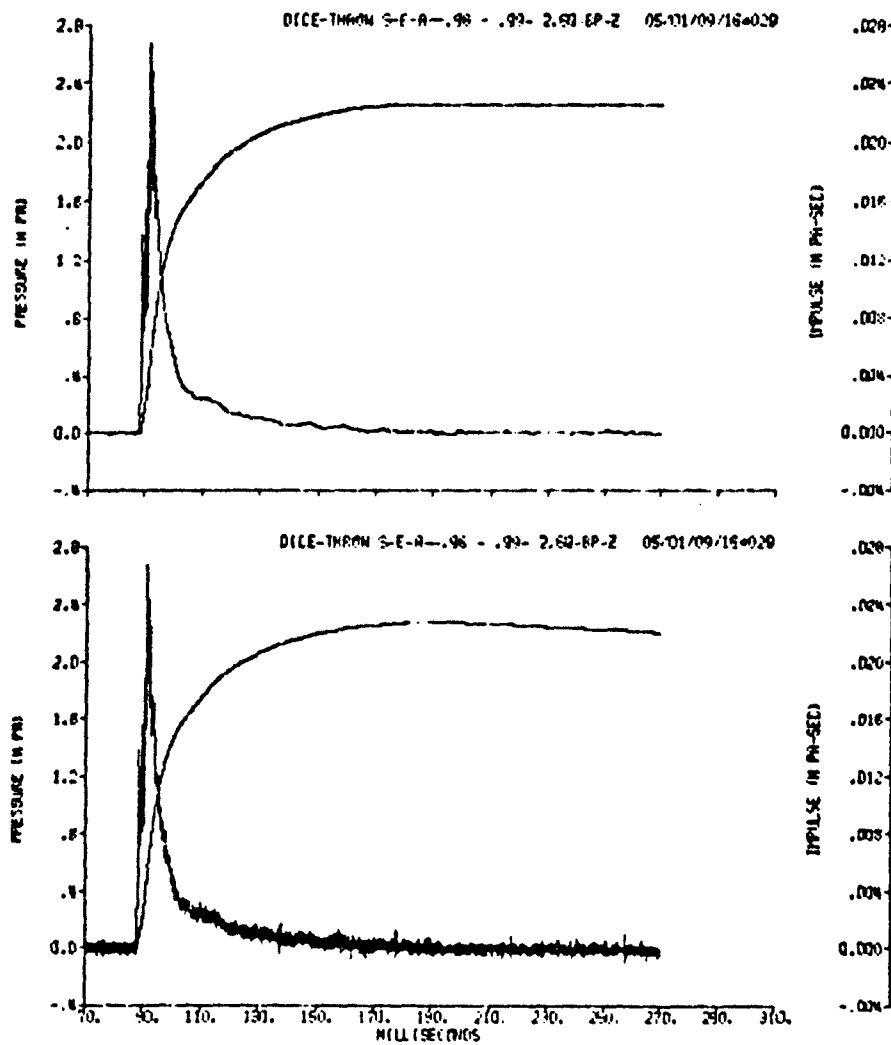
## DICE THROW, SHELTER A DATA CORRECTIONS (cont'd)

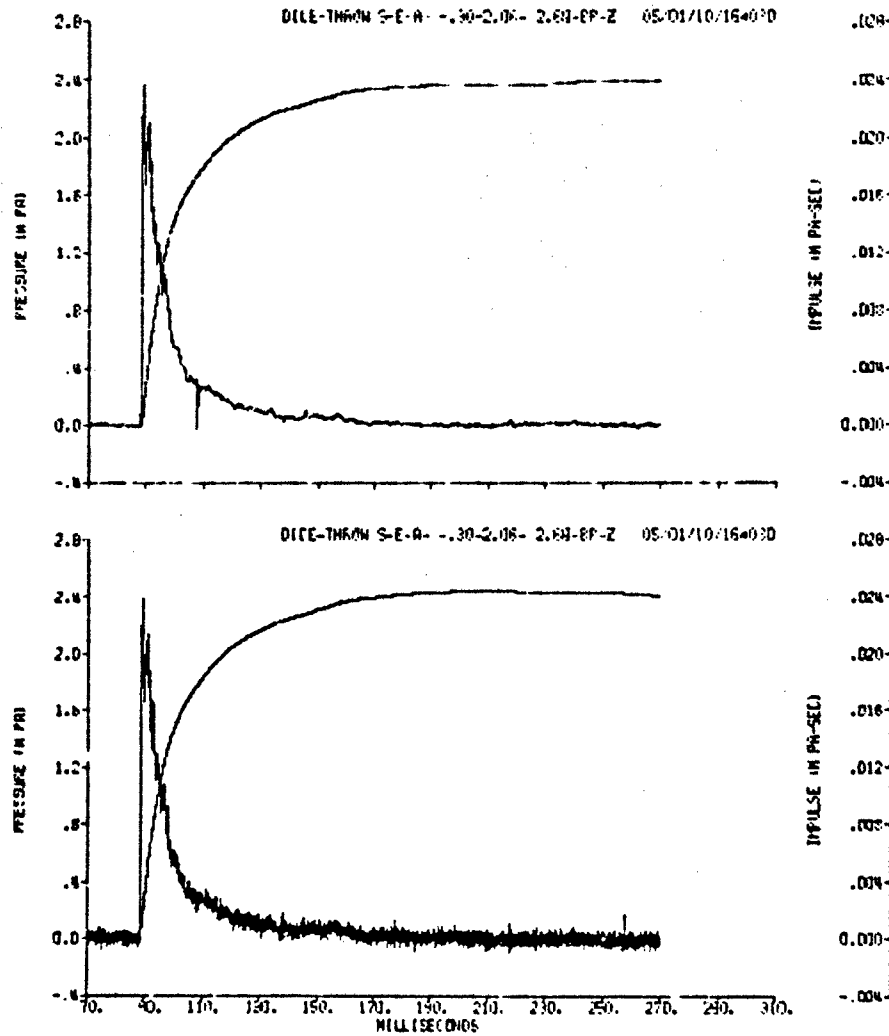
MEAS. NO.	COORDINATES			Z METERS	MEAS. TYPE	SENS. AXIS	DATA CORRECTIONS	GENERAL LOCATIONS
	X METERS	Y METERS						
301	.68	2.39		3.00	RD	Z	DSP, SMT	Inside Top of Closure
302	.68	2.39		3.00	RD	Z	Passive Gage	Inside Top of Closure
304	.68	0		3.00	RD	Z	Passive Gage, No Data	Inside Bottom of Closure
461	0	2.36		2.44	SS	Y	DSP, SMT	External of Closure, Steel Plate
462	0	2.36		3.25	SS	Y	DSP, SMT	Internal of Closure, Steel Plate
463	0	1.45		2.44	SS	Y	DSP, SMT	External of Closure, Steel Plate
464	0	1.45		3.25	SS	Y	DSP, SMT, FIL	Internal of Closure, Steel Plate
465	0	.38		2.44	SS	Y	DSP, SMT	External of Closure, Steel Plate
466	0	.38		3.25	SS	Y	DSP, SMT	Internal of Closure, Steel Plate
467	0.30	0		2.44	SS	X	DSP, SMT	External of Closure, Steel Plate
468	0.30	0		3.25	SS	X	DSP, SMT	Internal of Closure, Steel Plate
469	1.22	0		2.44	SS	X	DSP, SMT	External of Closure, Steel Plate
470	1.22	0		3.25	SS	X	DSP, SMT	Internal of Closure, Steel Plate
471	.91	.91		2.69	SS	45	DSP, SMT	External of Closure, Steel Plate
472	.91	.91		3.00	SS	45	DSP, SMT	Internal of Closure, Steel Plate
473	.91	.91		2.69	SS	Y	DSP, SMT	External of Closure, Steel Plate
474	.91	.91		3.00	SS	Y	DSP, SMT	Internal of Closure, Steel Plate
475	.91	.91		2.69	SS	X	DSP, SMT	External of Closure, Steel Plate
476	.91	.91		3.00	SS	X	DSP, SMT	Internal of Closure, Steel Plate
477	.46	.46		2.69	SS	Y	DSP, SMT	External of Closure, Steel Plate
478	.46	.46		3.00	SS	Y	DSP, SMT	Internal of Closure, Steel Plate
479	.46	.46		2.69	SS	X	DSP, SMT	External of Closure, Steel Plate
480	.46	.46		3.00	SS	X	DSP, SMT	Internal of Closure, Steel Plate
481	.57	1.74		2.69	SS	Y	DSP, SMT	External of Closure, Steel Plate
482	.57	1.74		3.00	SS	Y	DSP, SMT	Internal of Closure, Steel Plate
483	.57	1.74		2.69	SS	X	DSP, SMT	External of Closure, Steel Plate
484	.57	1.74		3.00	SS	X	DSP, SMT	Internal of Closure, Steel Plate
485	1.36	1.36		2.69	SS	X	DSP, SMT	External of Closure, Steel Plate
486	1.36	1.36		3.00	SS	X	DSP, SMT	Internal of Closure, Steel Plate
487	1.36	1.36		2.69	SS	X	DSP, SMT	External of Closure, Steel Plate
488	1.36	1.36		3.00	SS	Y	Scatched	Internal of Closure, Steel Plate
489	1.85	.56		2.69	SS	Y	DSP, SMT	External of Closure, Steel Plate

## DICE THROW, FILTER A DATA CORRECTIONS (cont'd)

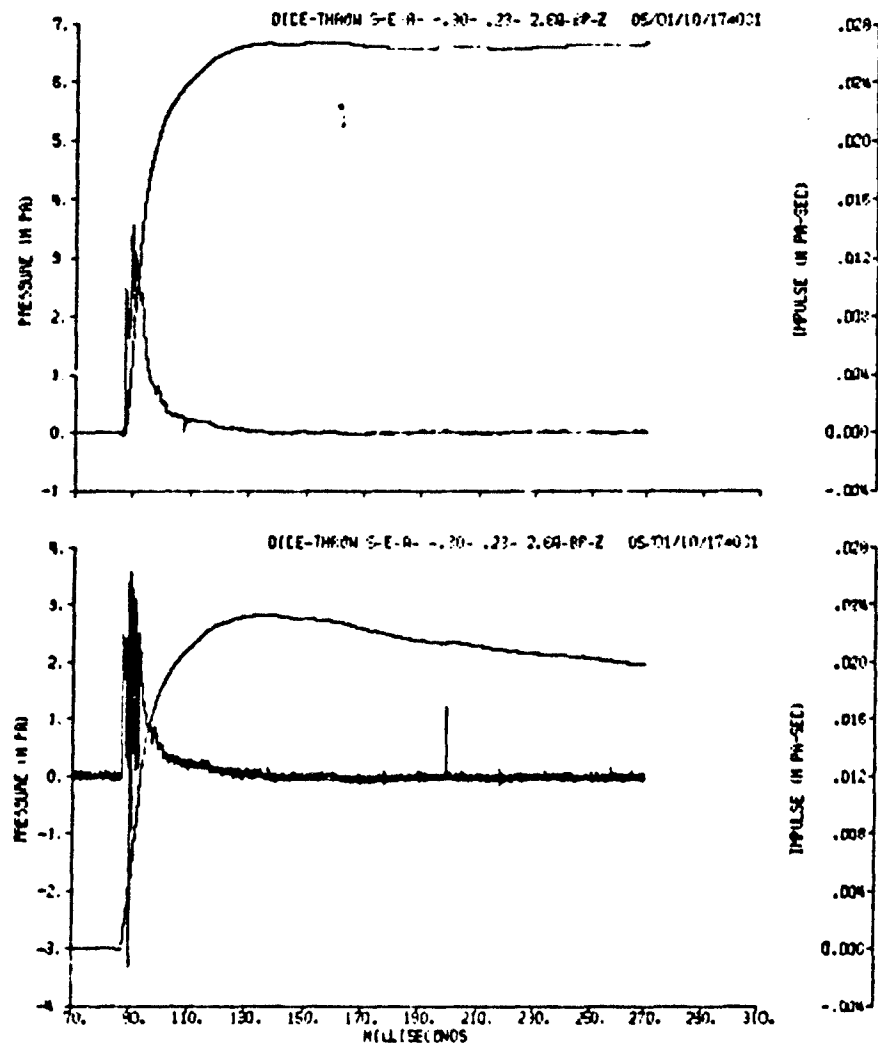
MEAS. NO.	COORDINATES			Z METERS	MEAS. TYPE	SENS. AXIS	DATA CORRECTIONS	GENERAL LOCATIONS
	X METERS	Y METERS						
490	1.85	.56		3.00	SS	Y	DSP, SMT	Internal of Closure, Steel Plate
491	1.85	.56		2.69	SS	X	DSP, SMT	External of Closure, Steel Plate
492	1.85	.56		3.00	SS	X	DSP, SMT	Internal of Closure, Steel Plate
493	0	-.08		3.17	HS	Z	DSP, SMT	In Foundation
494	0	-.20		3.12	HS	45	DSP, SMT	In Foundation
495	0	-.23		3.17	SE	Z	DSP, SMT	In Foundation
496	0	-.30		3.17	SE	Z	DSP, SMT	In Foundation
497	0	-.35		3.17	SE	Z	DSP, SMT	In Foundation
498	0	-.10		3.33	SE	X	DSP, SMT	In Foundation
499	0	-.20		3.33	SE	X	DSP, SMT	In Foundation
500	0	-.28		3.33	SE	X	DSP, SMT	In Foundation
501	0	-.23		2.84	HS	Z	DSP, SMT	In Foundation
502	0	-.23		2.84	SE	Z	DSP, SMT	In Foundation
503	0	-.30		2.84	SE	Z	DSP, SMT	In Foundation
504	0	-.38		2.84	HS	Z	DSP, SMT	In Foundation
505	0	-.35		2.84	HS	Z	DSP, SMT	In Foundation
506	0	-.20		2.38	SE	X	DSP, SMT	In Foundation
507	0	0		2.74	SS	Z	DSP	Closure Key on Steel Plate
508	0	-.15		2.74	SS	Z	DSP, SMT	Closure Key on Steel Plate
509	0	0		2.94	SS	Z	DSP	Closure Key on Steel Plate
510	0	-.15		2.94	SS	Z	DSP, SMT	Closure Key on Steel Plate
511	0	-.10		2.84	SS	Z	DSP, SMT	Closure Key on Steel Plate
512	0	-.10		2.84	SS	Z	DSP, SMT	Closure Key on Steel Plate
513	0	-.10		2.84	SS	Z	DSP, SMT	Closure Key on Steel Plate
514	0	2.52		5.68	SE	45	DSP, SMT	Closure Key on Steel Plate
515	0	-.20		3.04	HS	Y	DSP, SMT	Crown of Arch
516	0	-.20		3.30	HS	Y	DSP, SMT	In Foundation
551	0	-.29		3.47	IP	X	DSP, SMT, BLC	Foundation
552	0	-.42		3.17	IP	Y	DSP, SMT, FIL, BLC	Foundation
553	0	-.42		2.48	IP	Y	DSP	Foundation

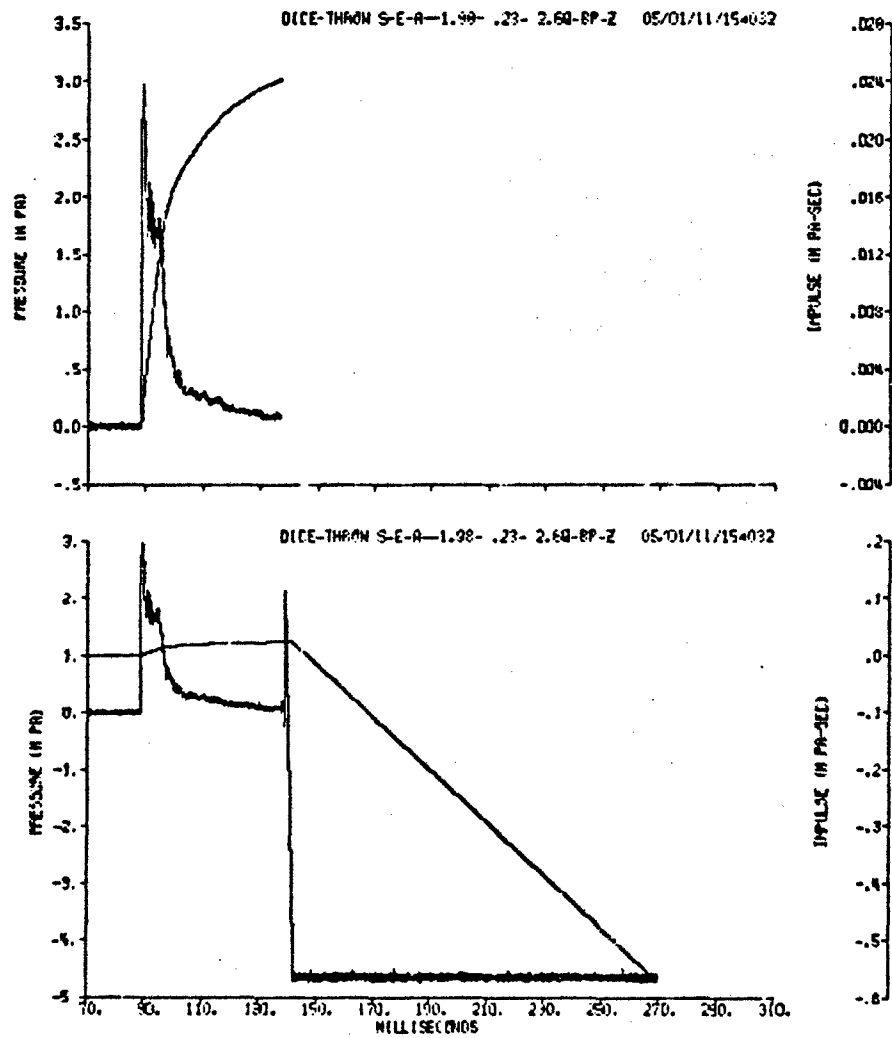
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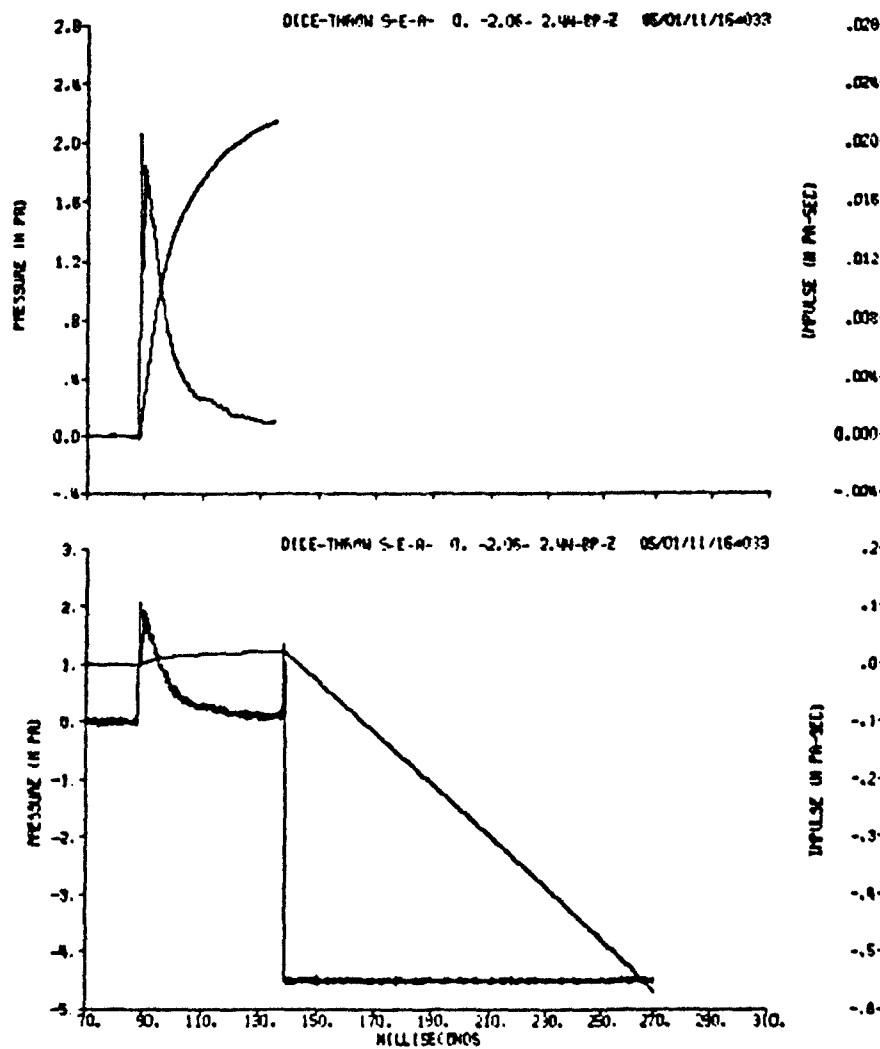


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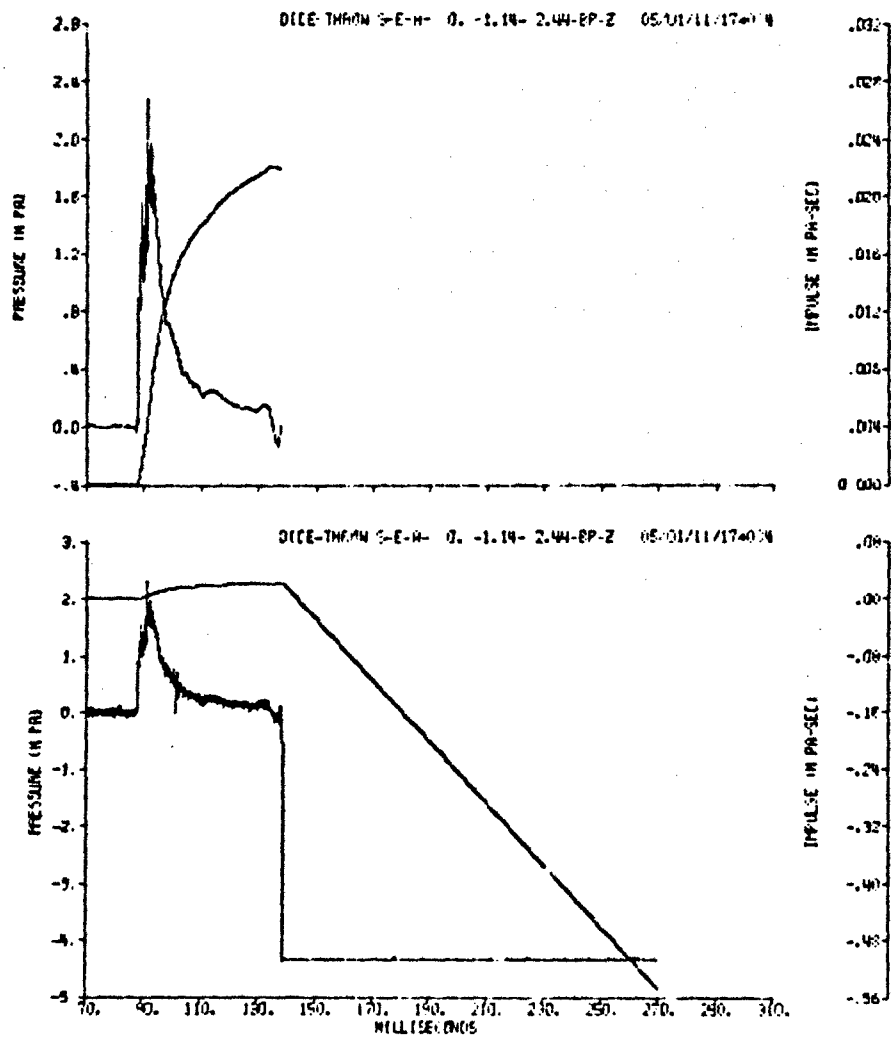


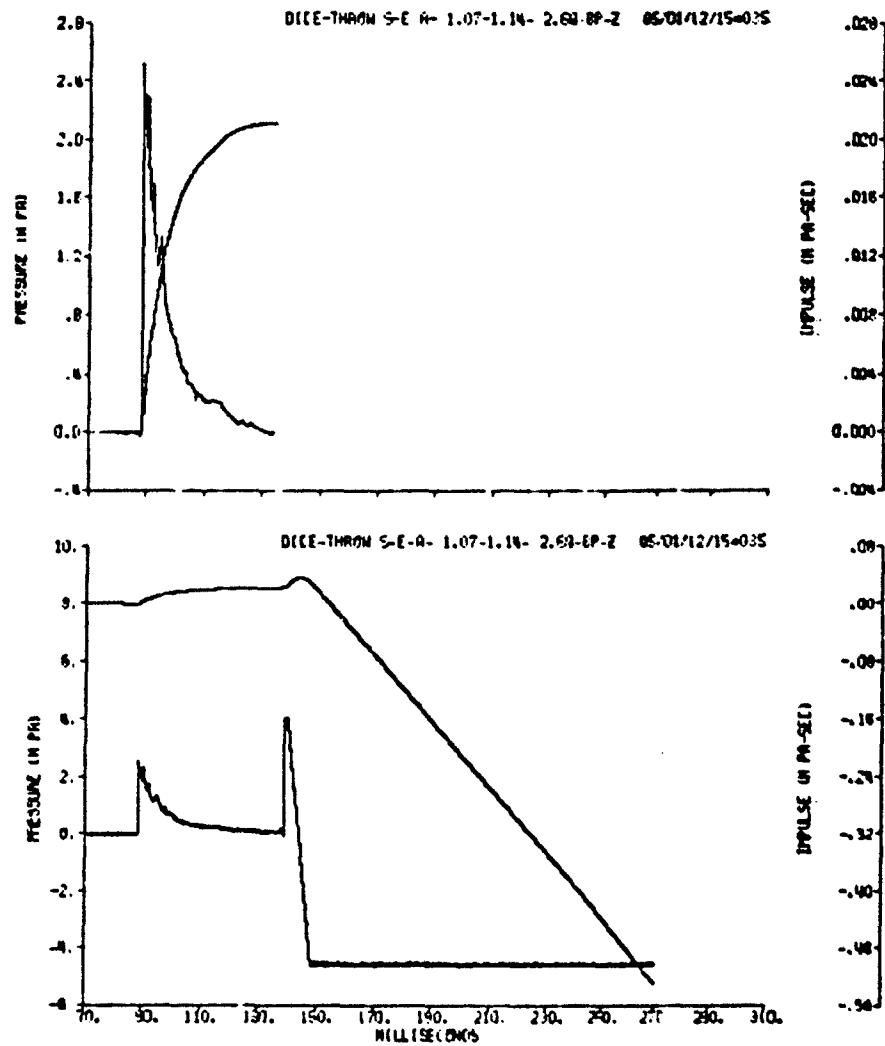


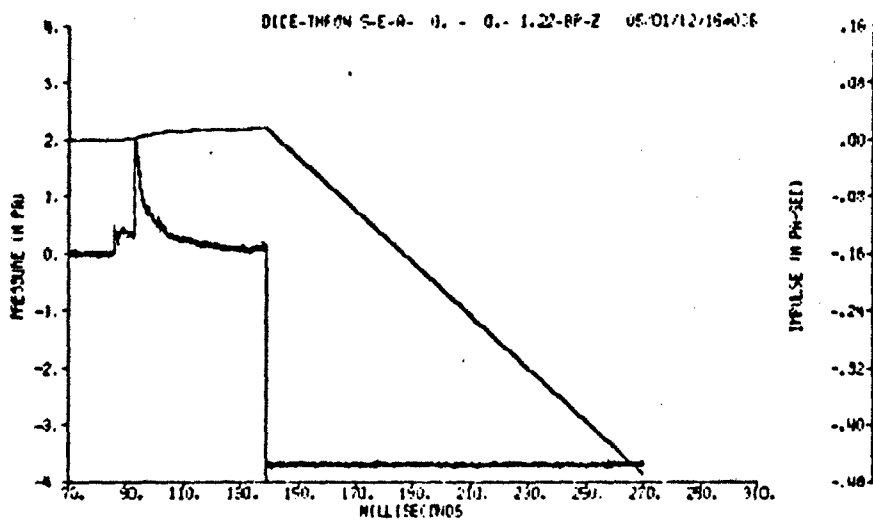
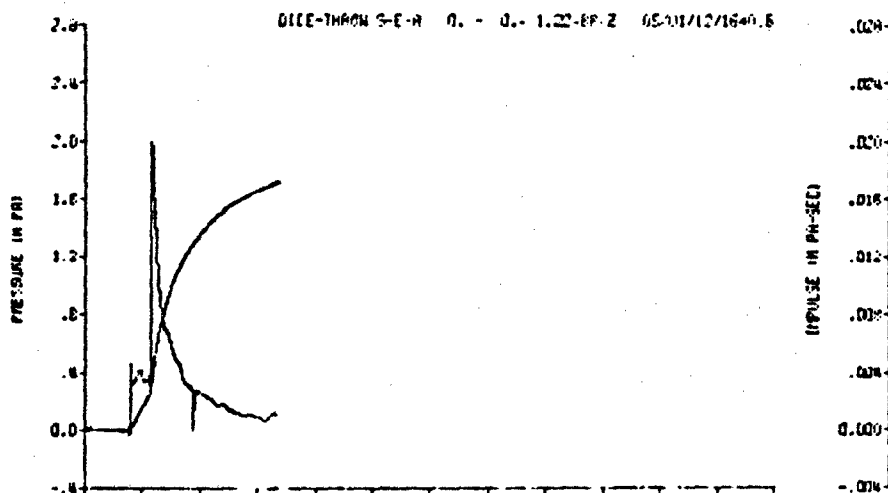
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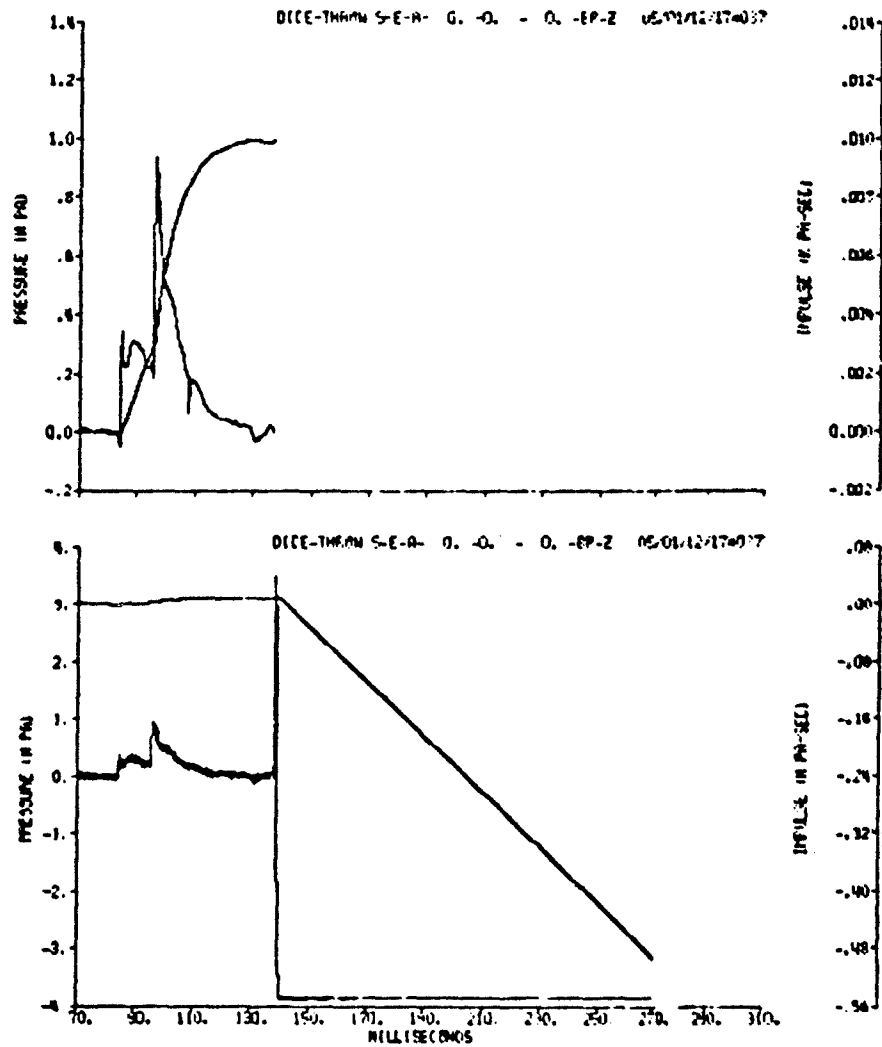


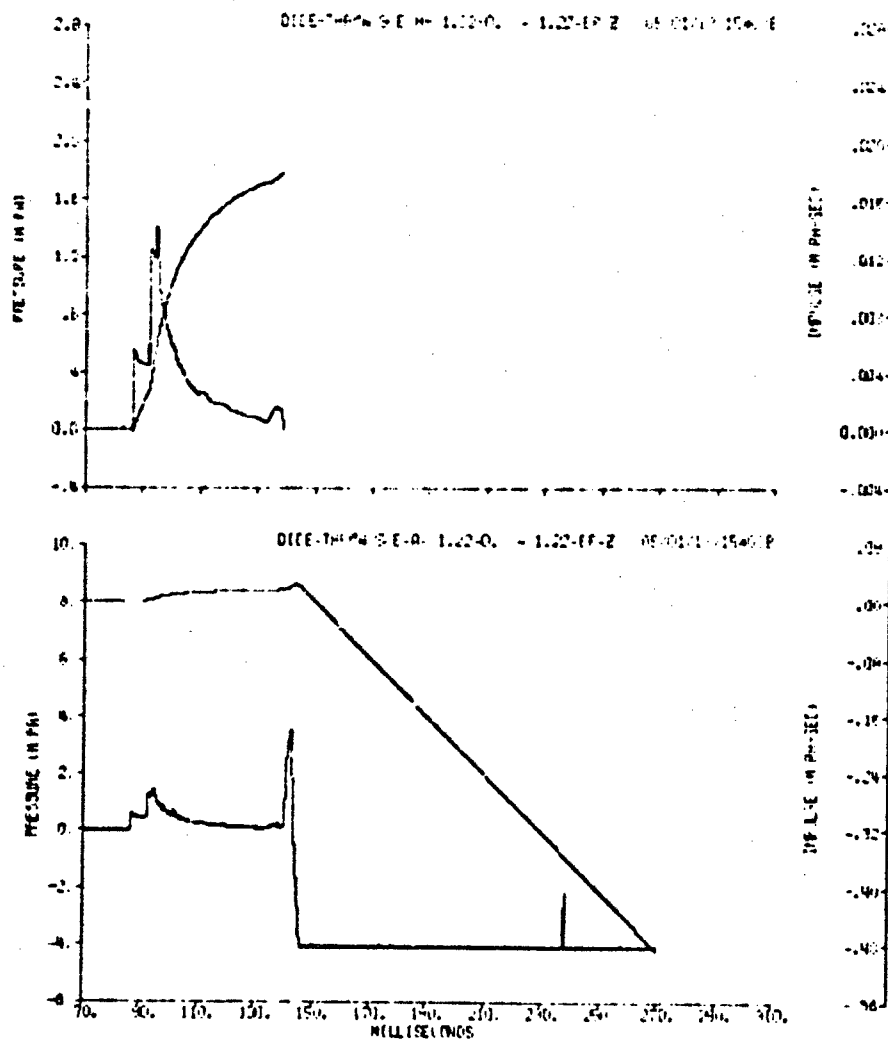


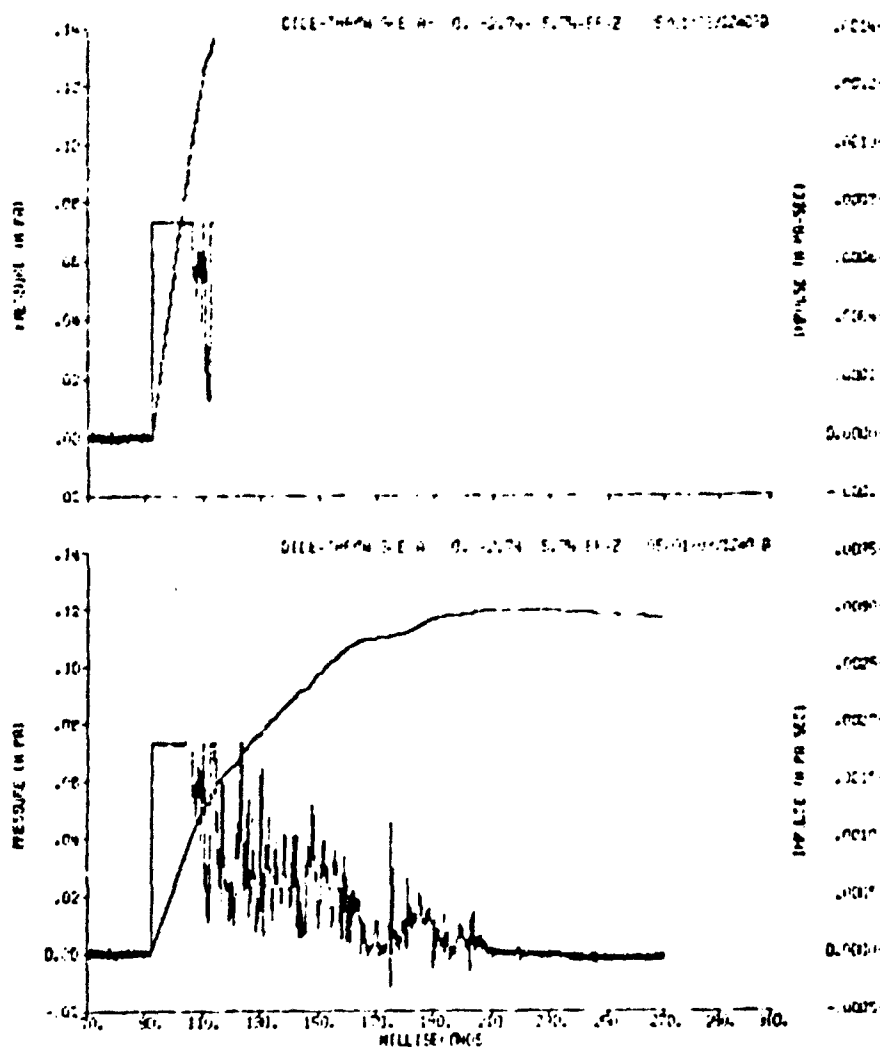




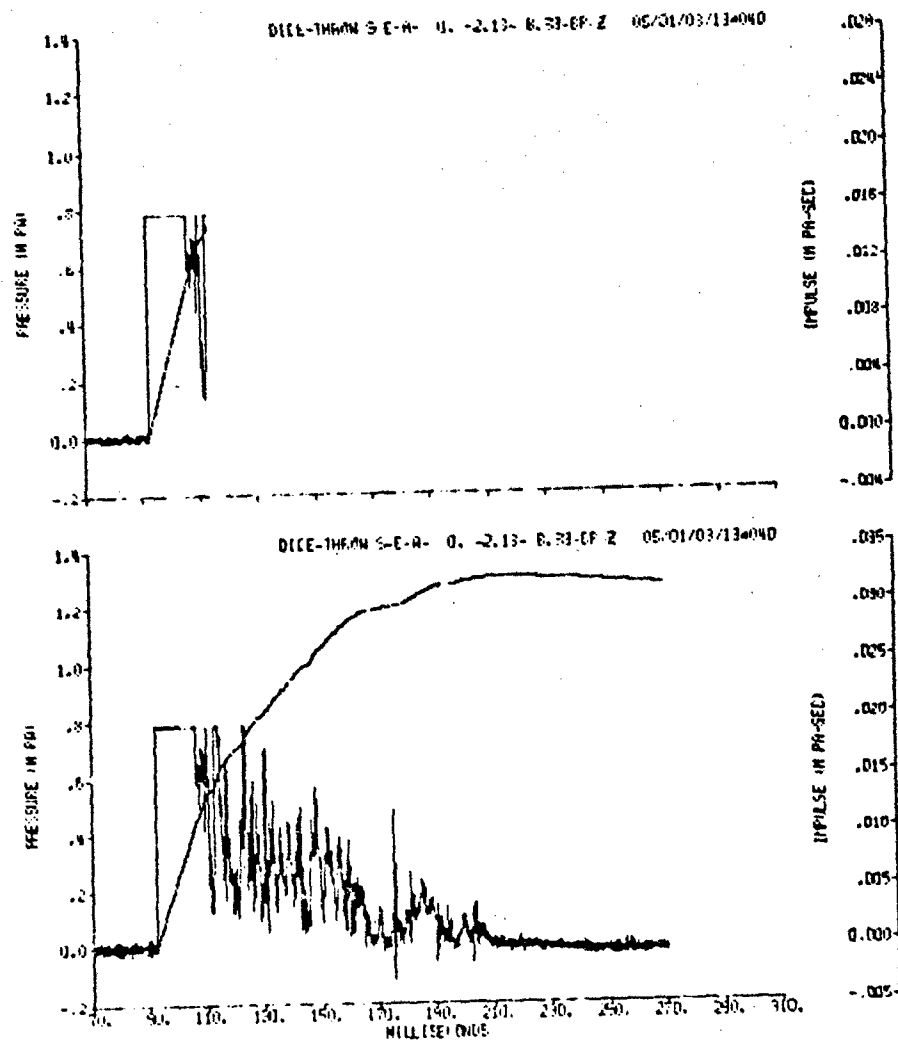


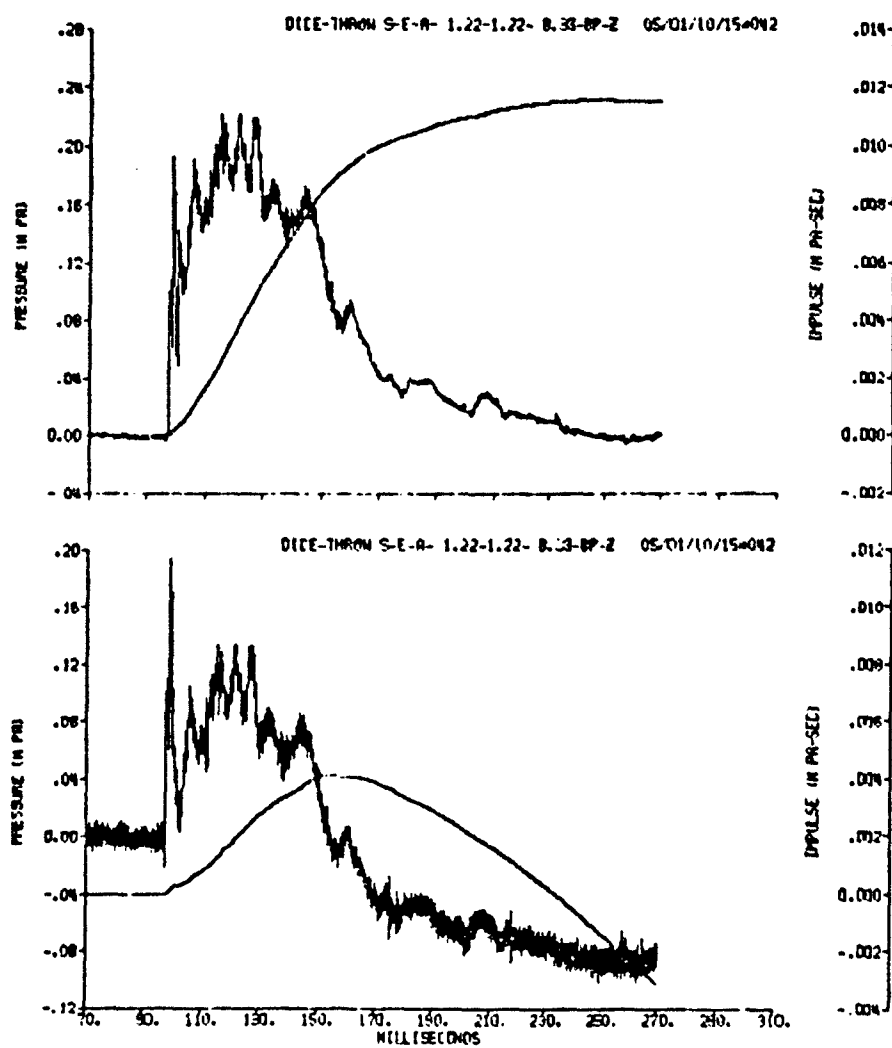






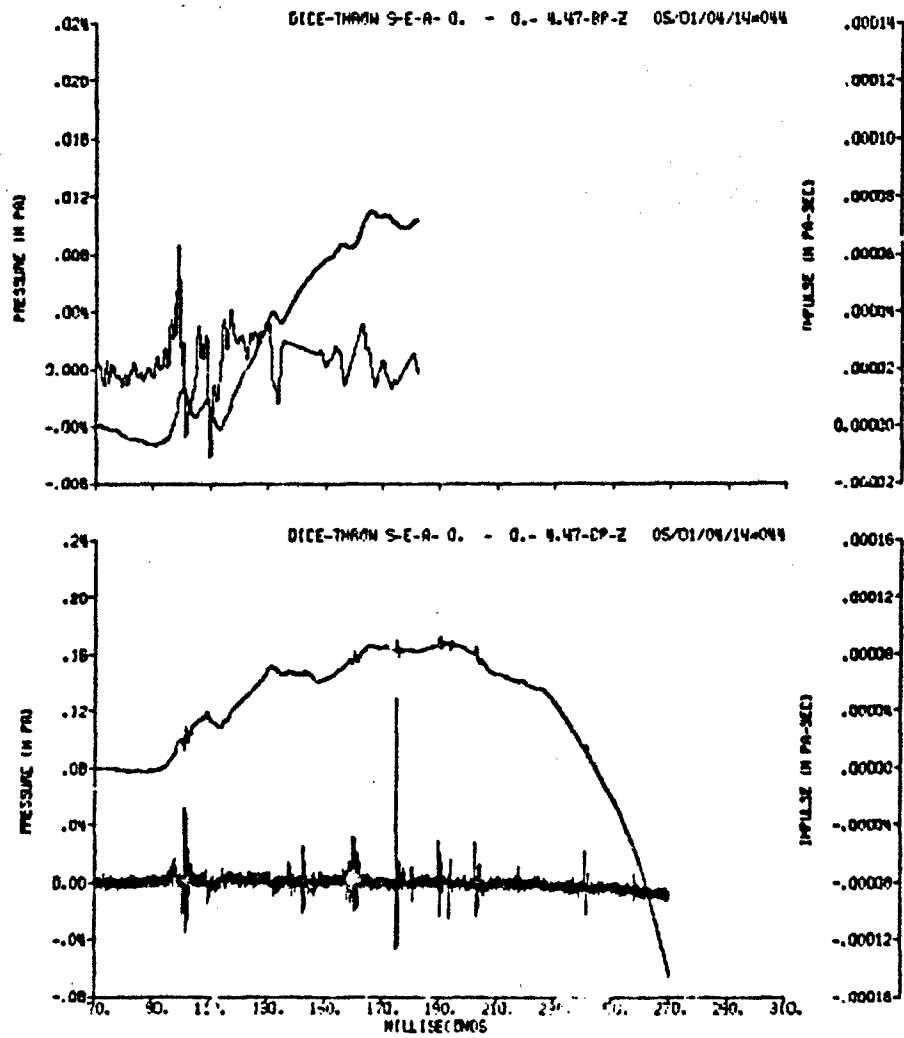
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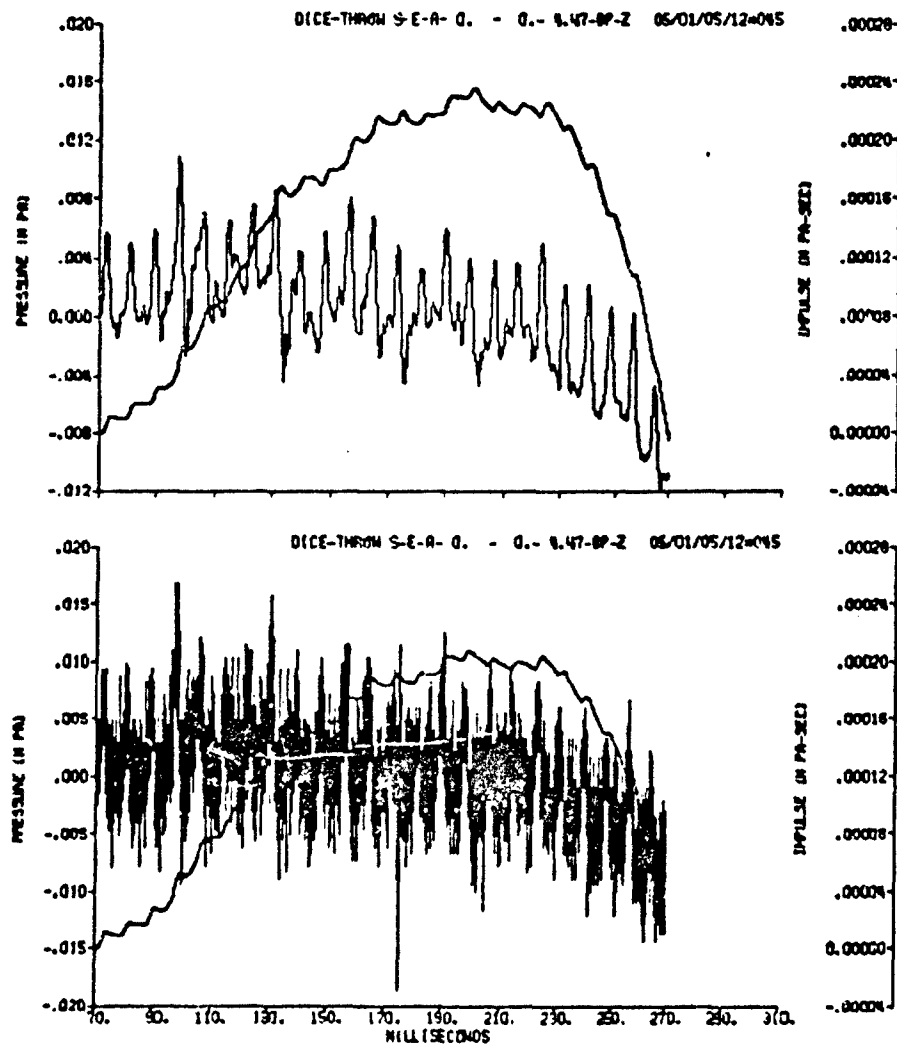




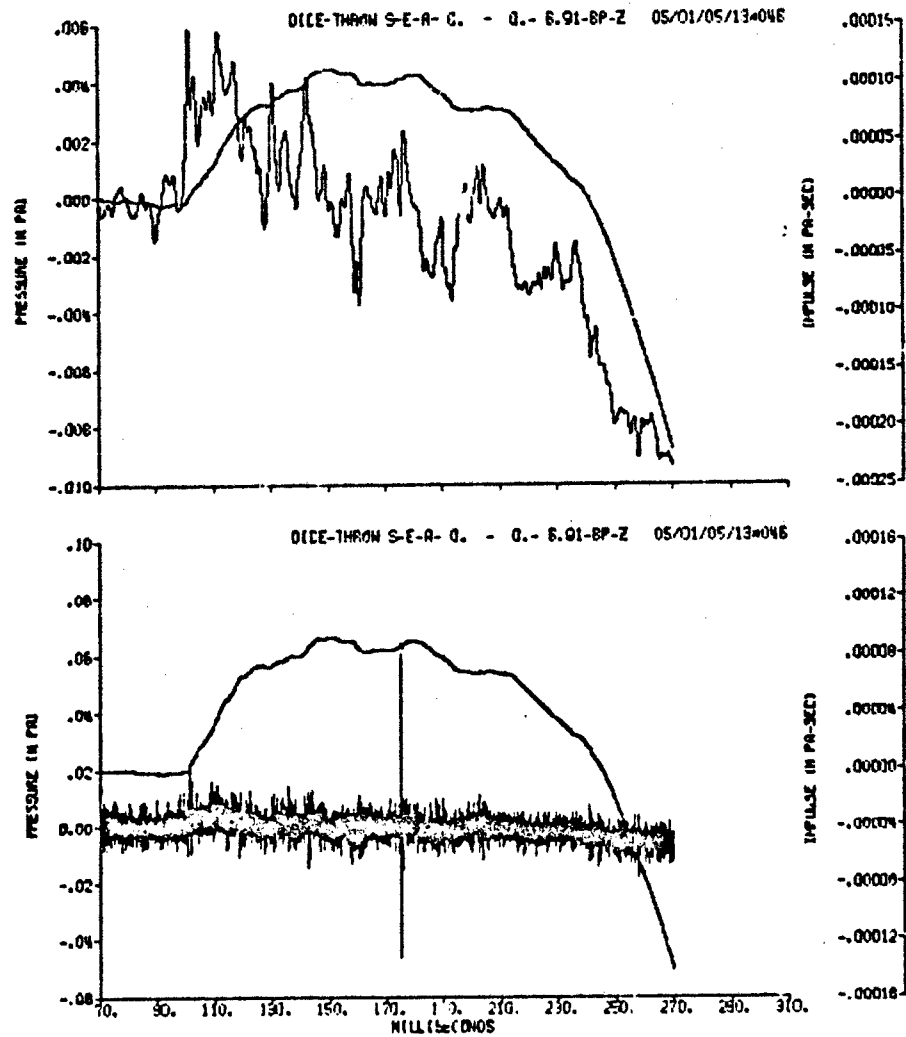


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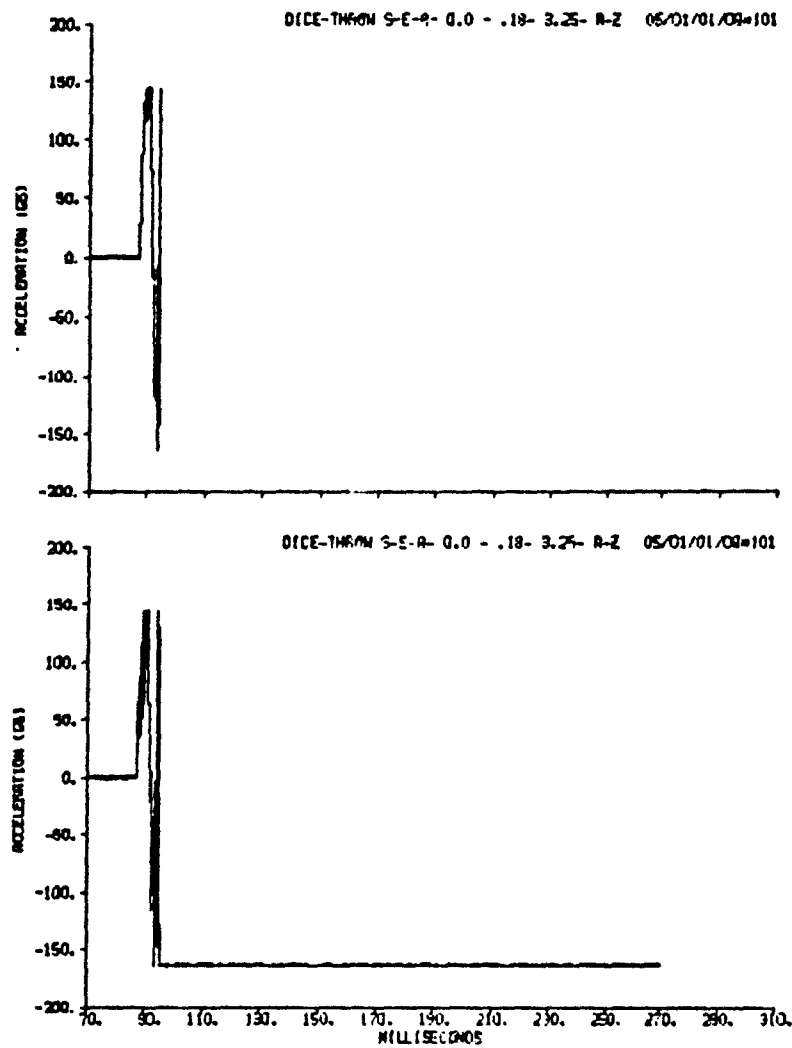


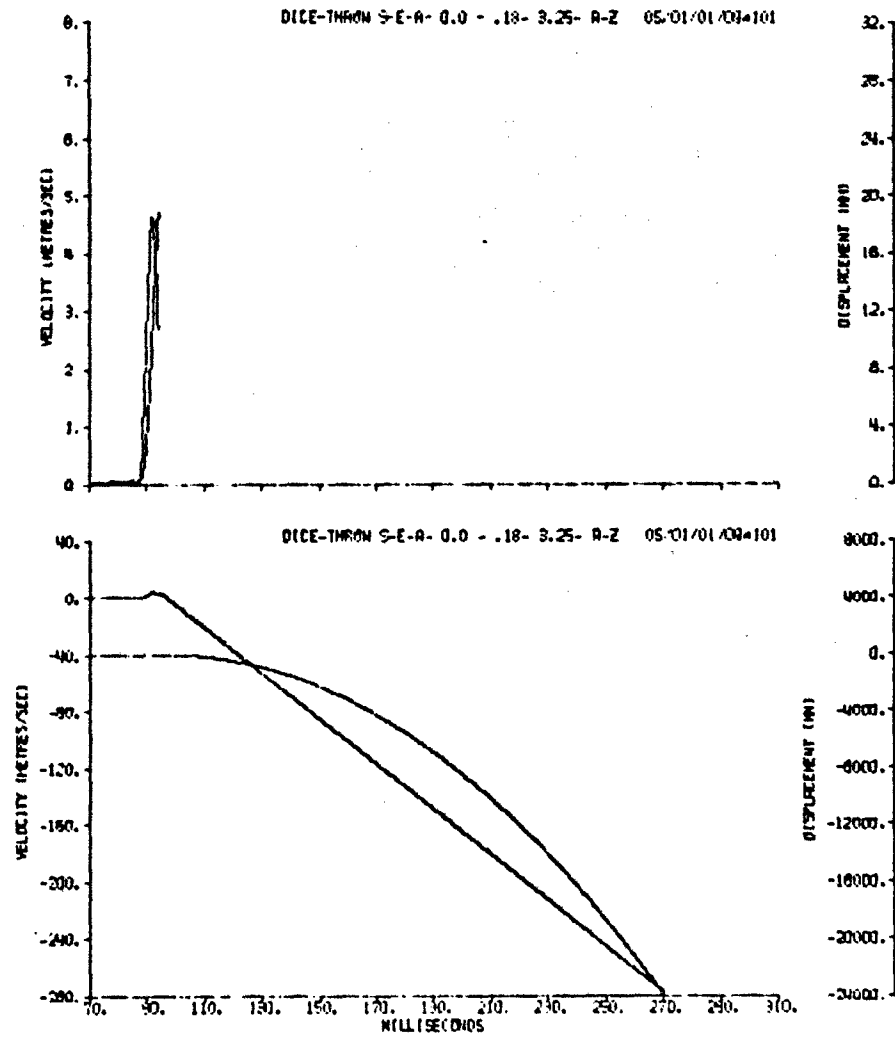


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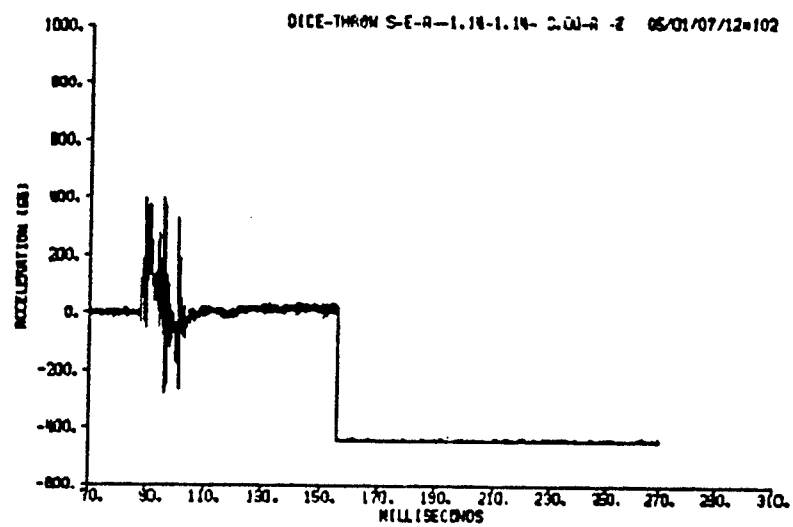
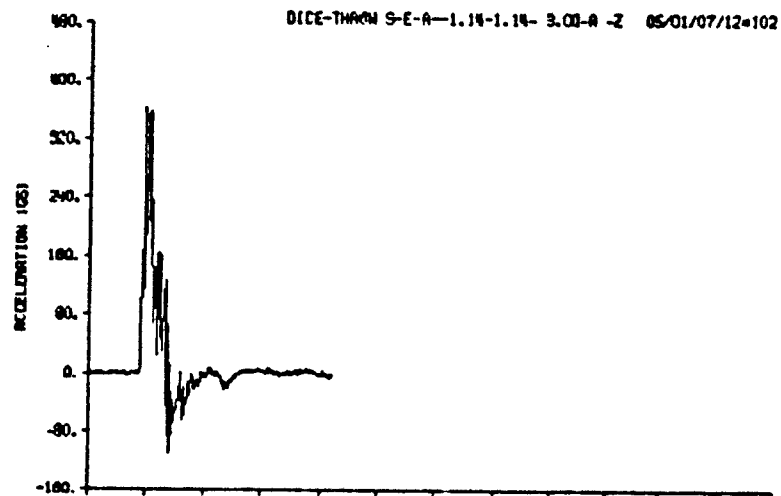


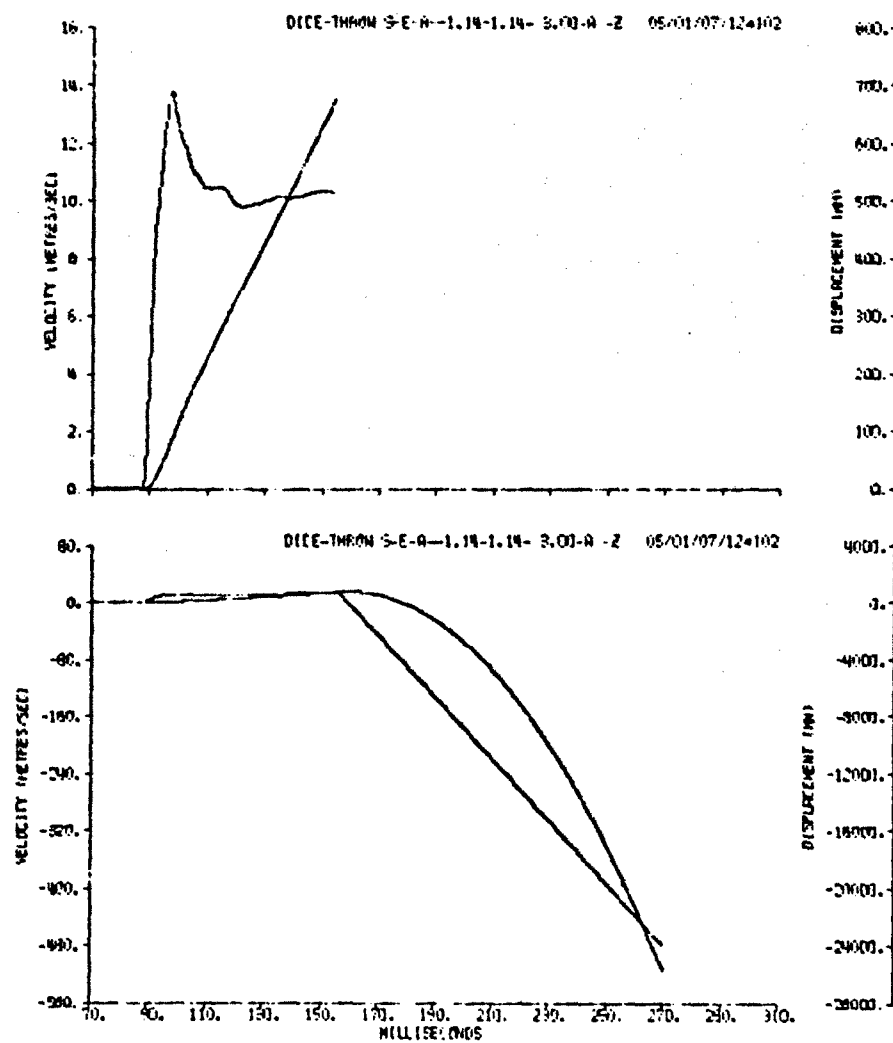
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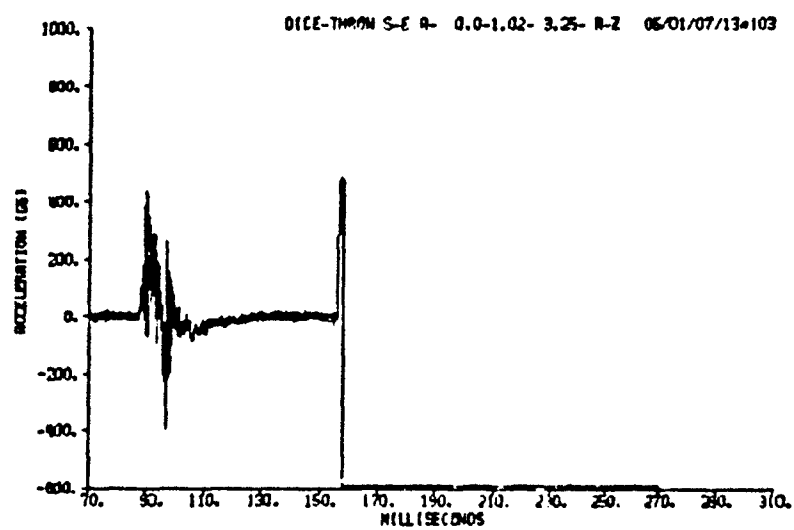
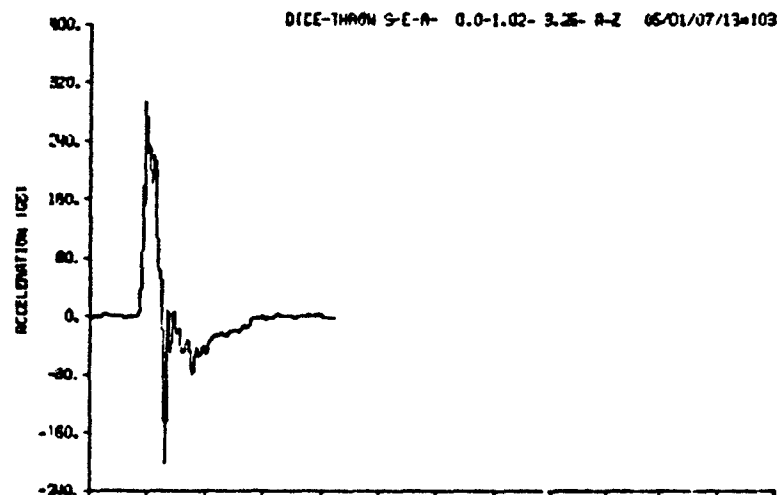




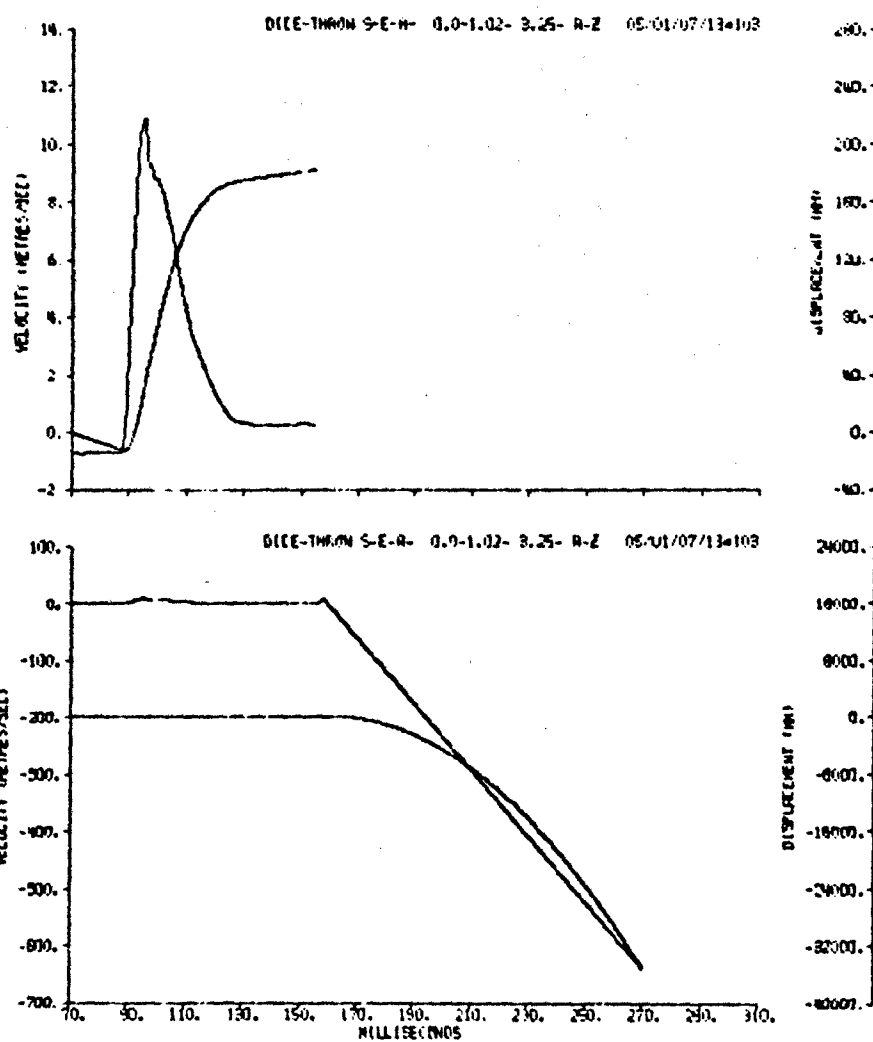
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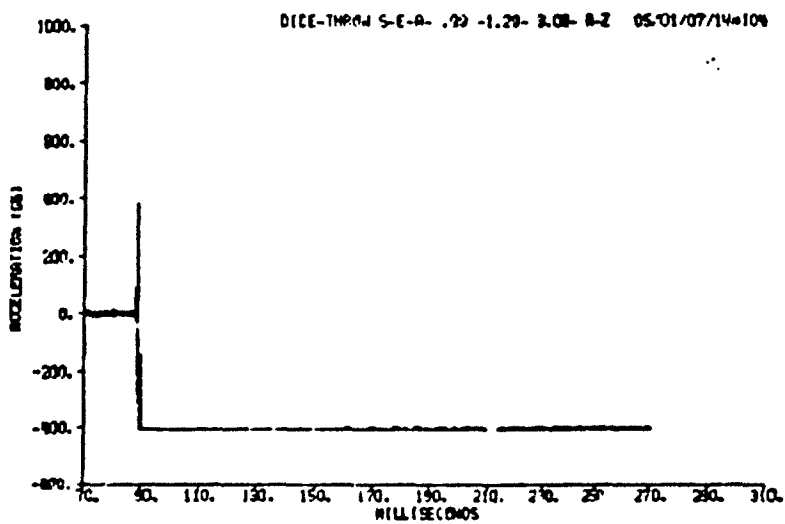
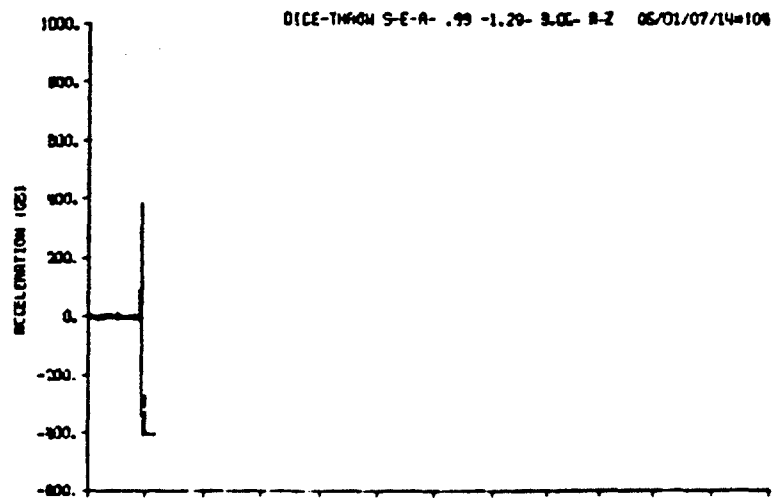


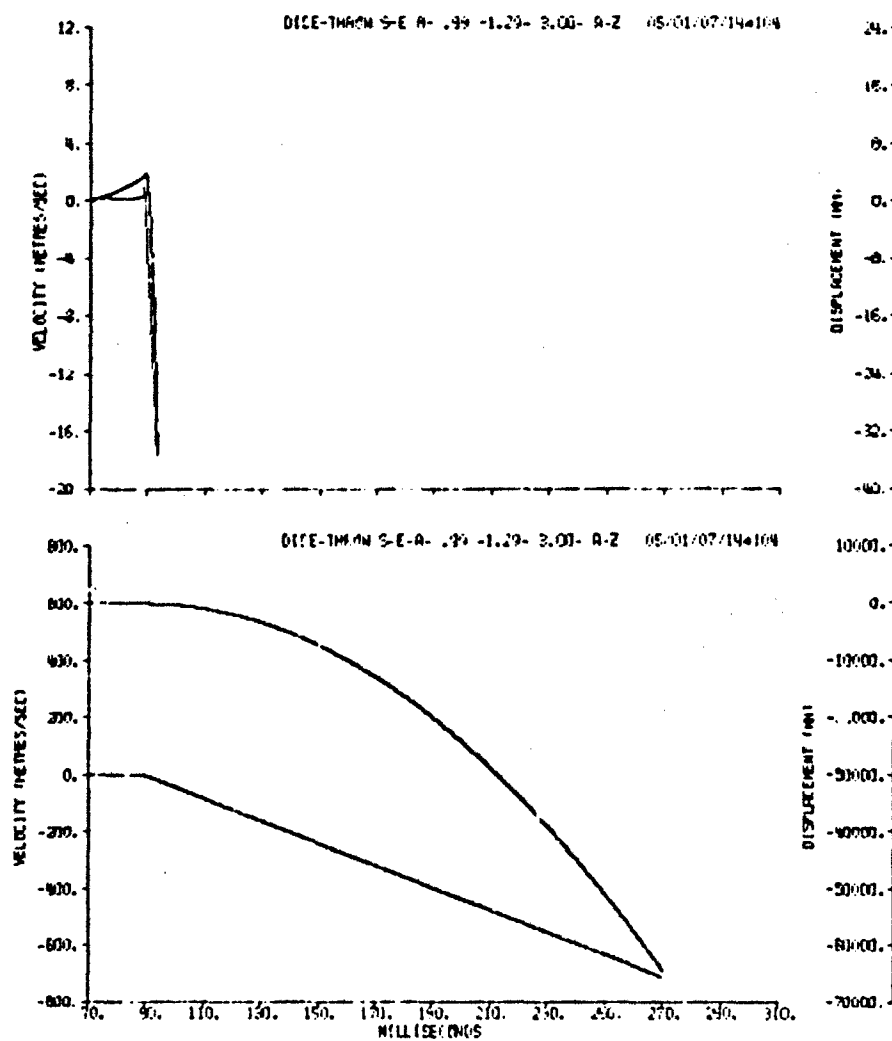


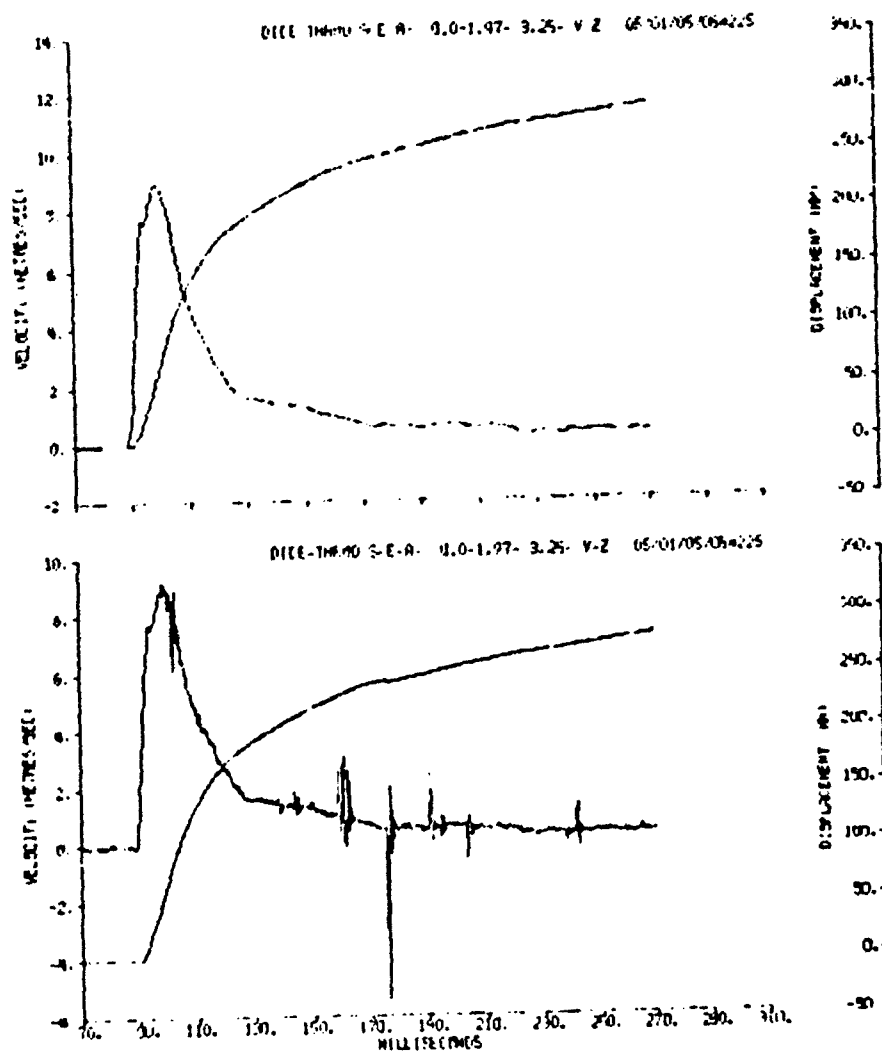




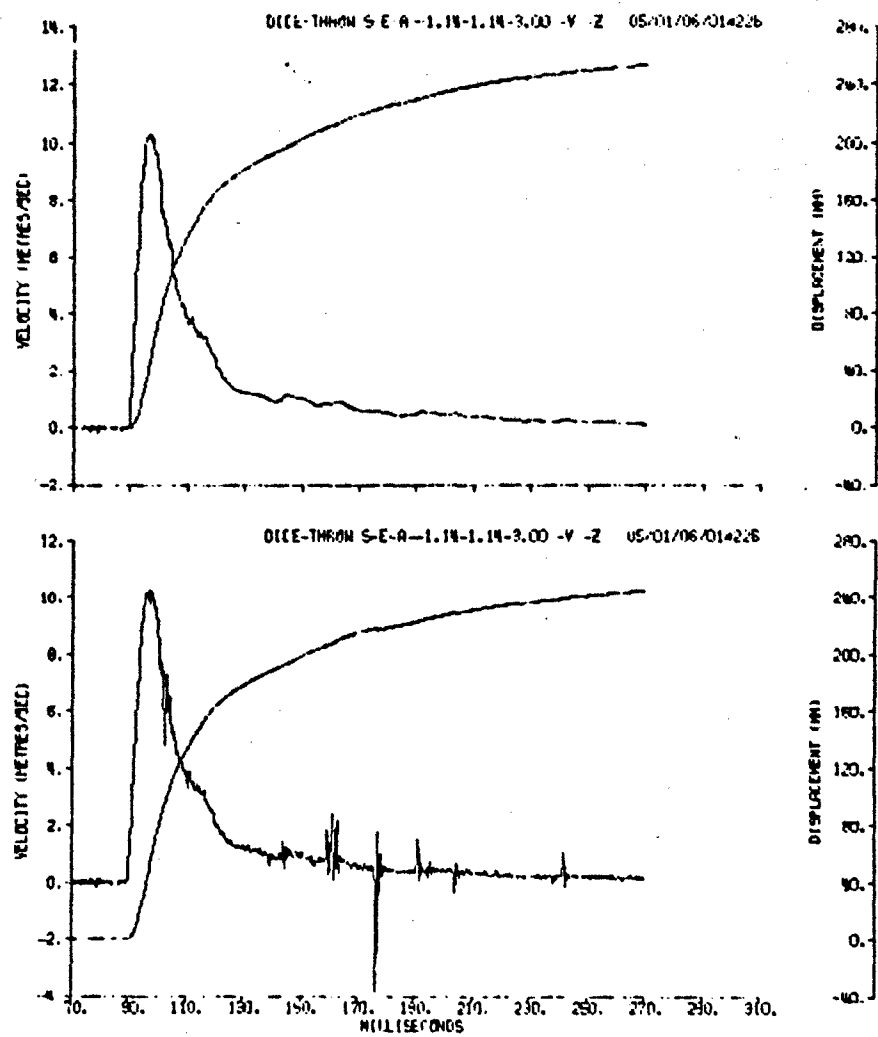


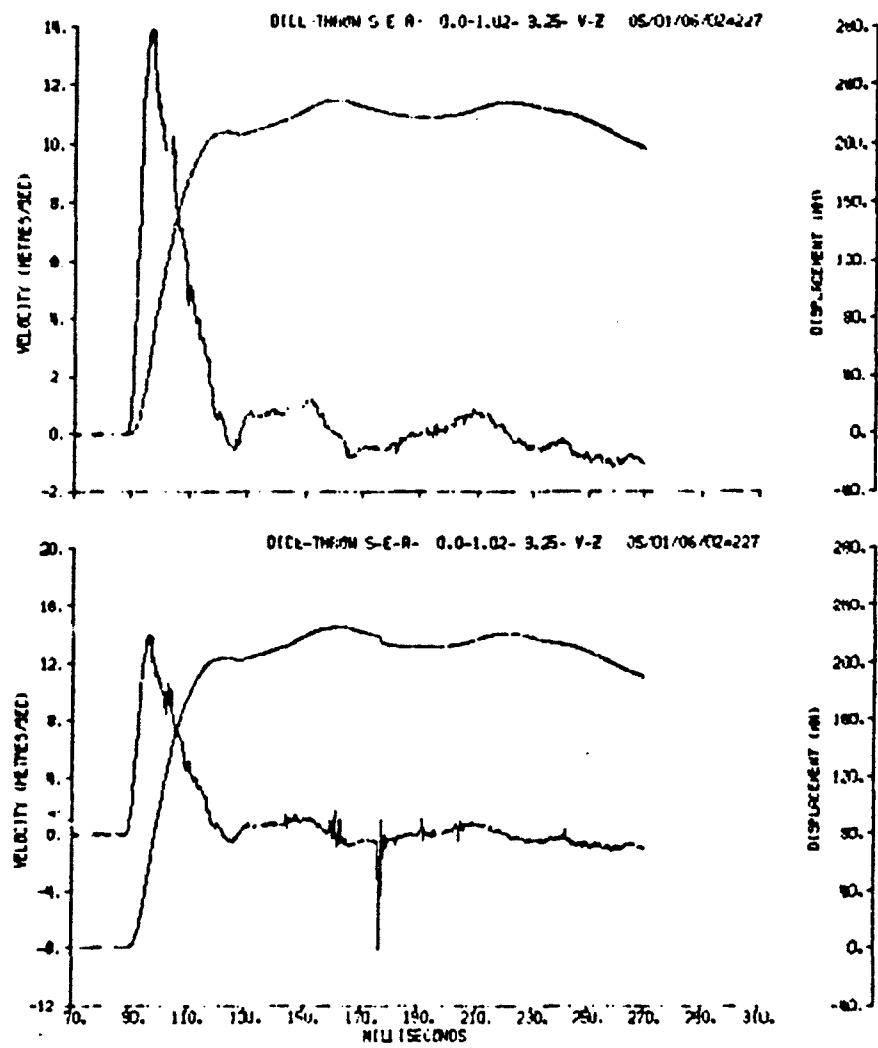


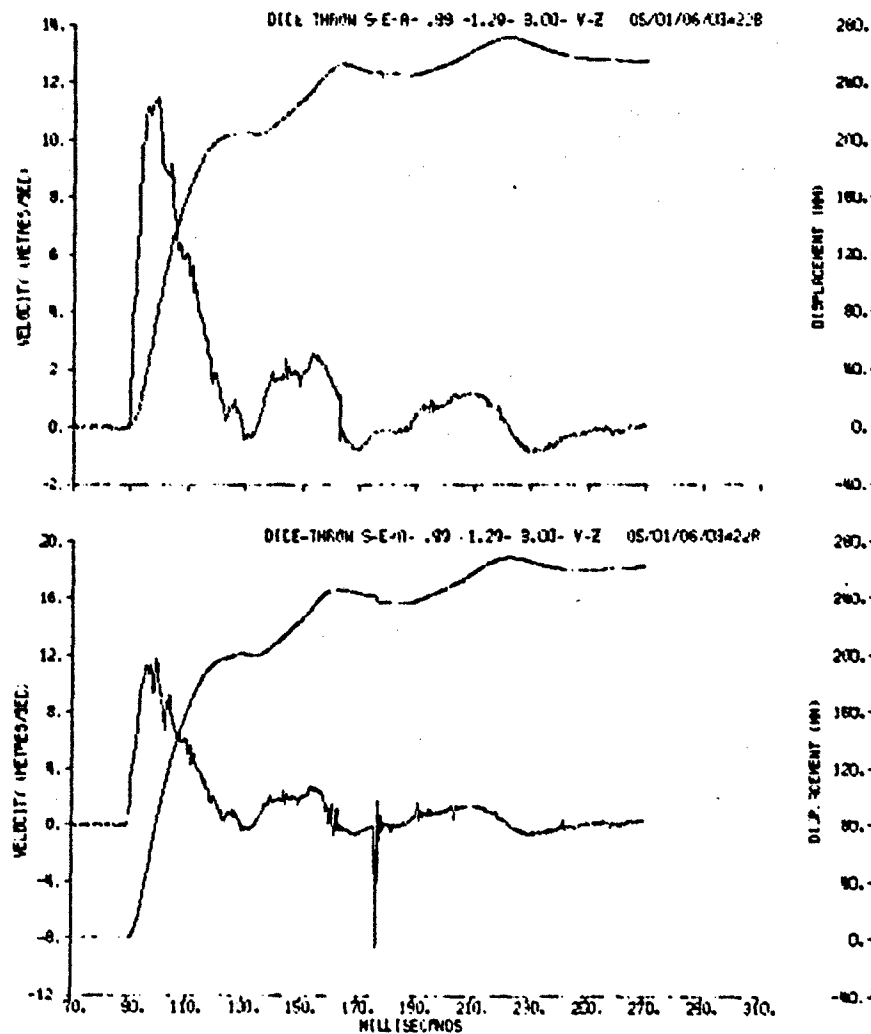


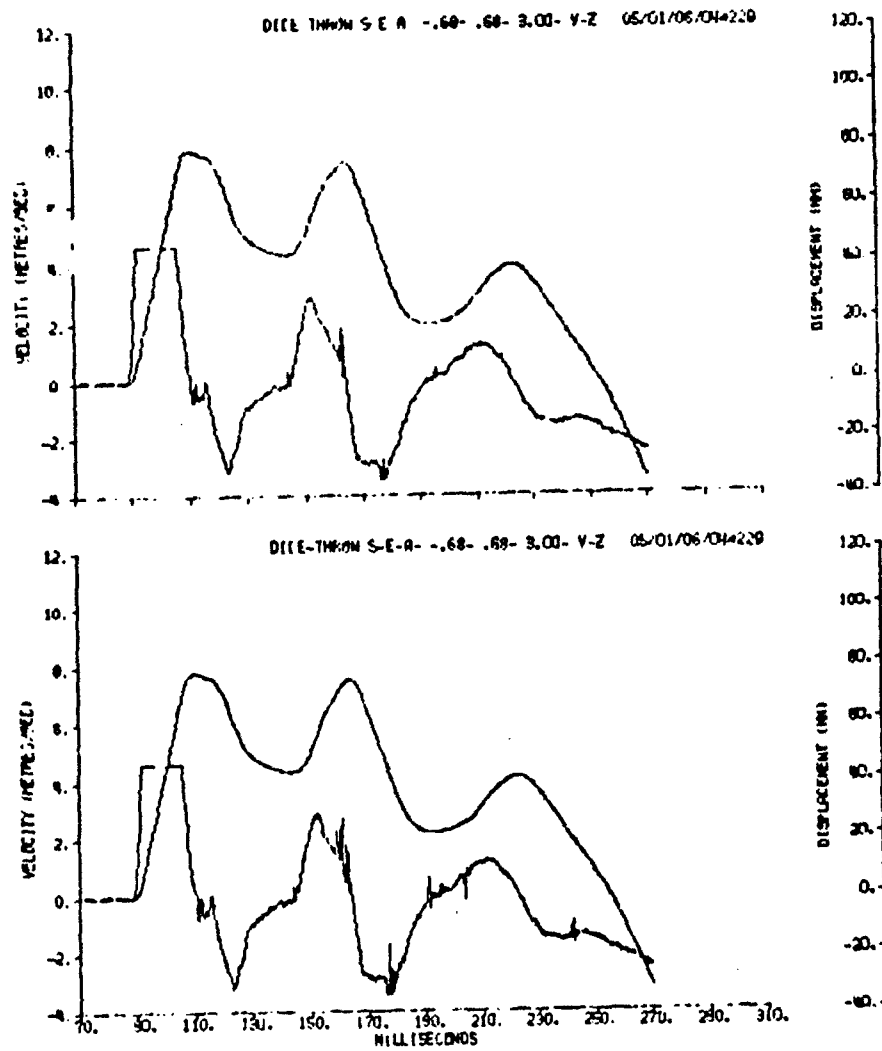


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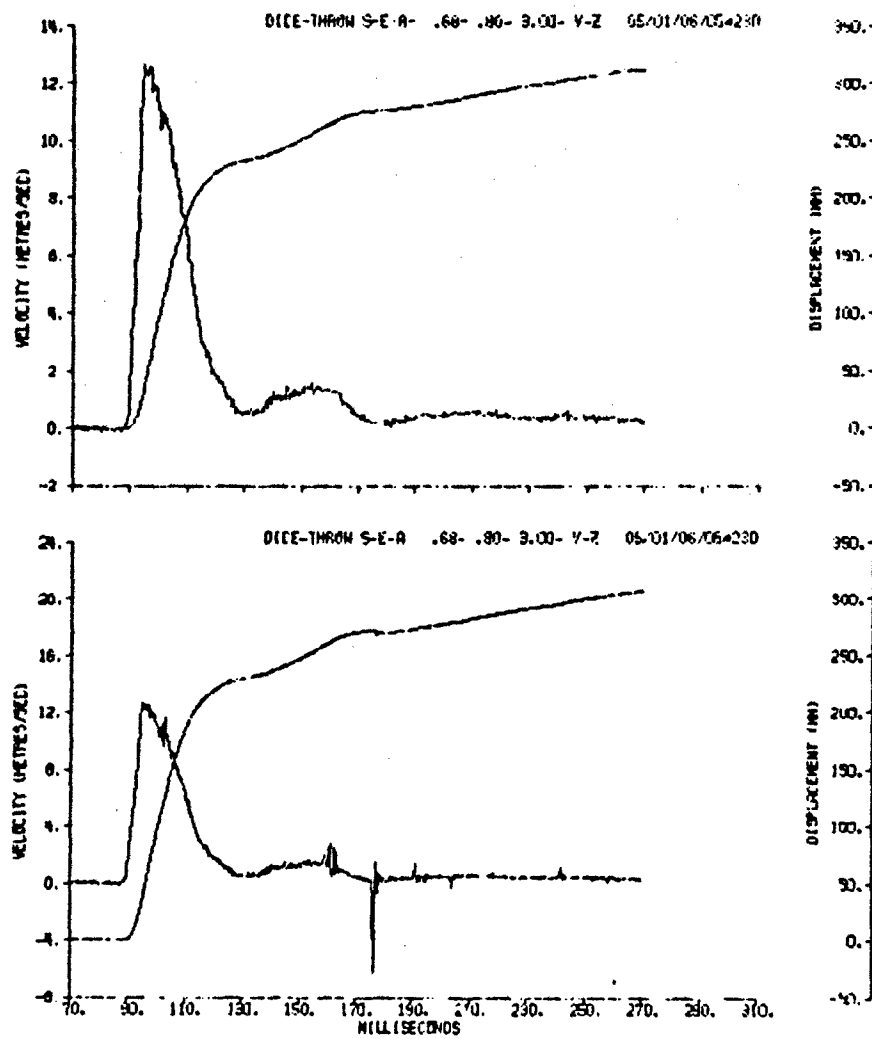


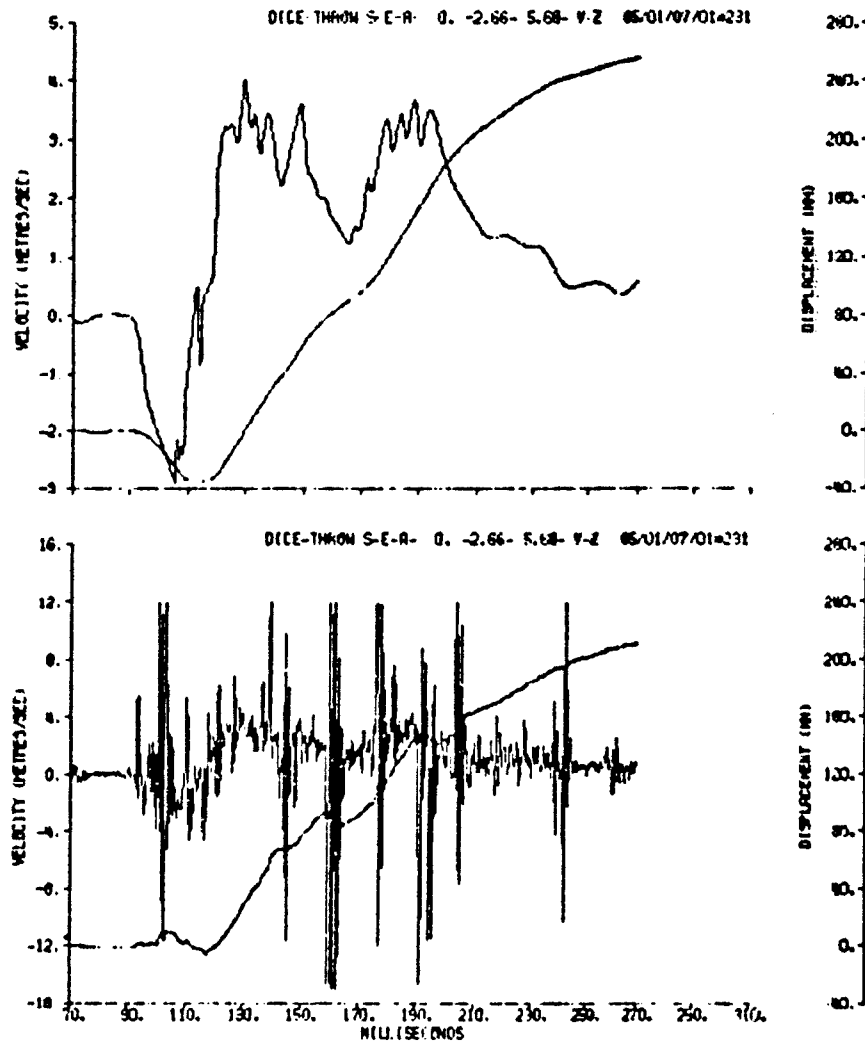




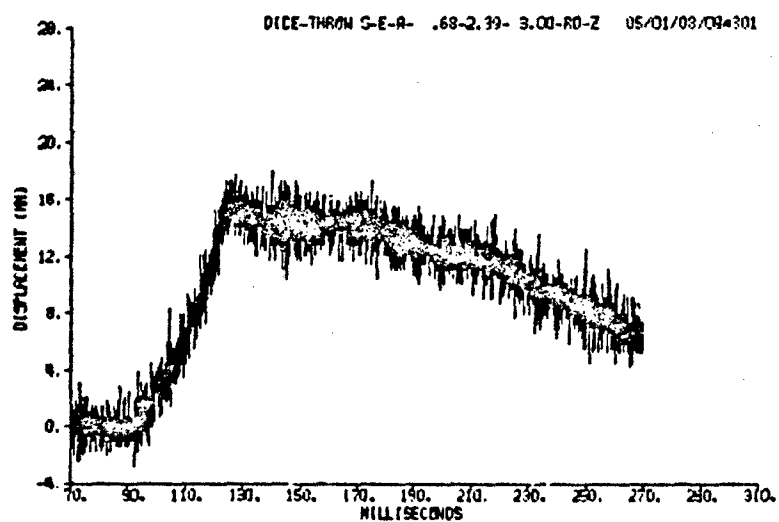
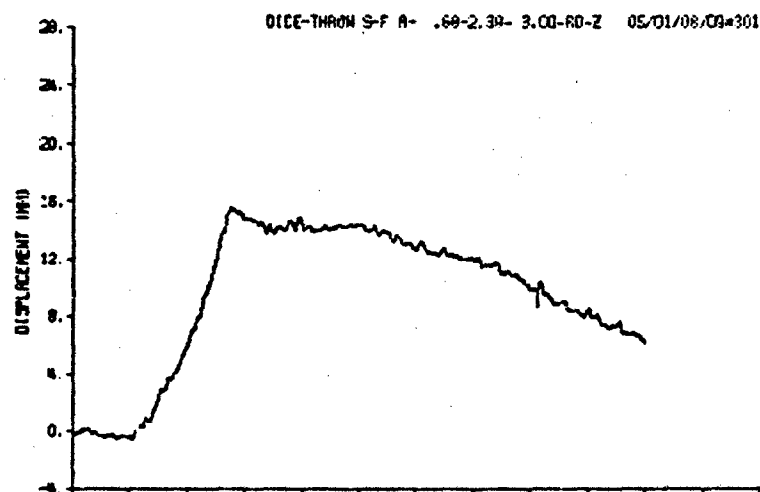




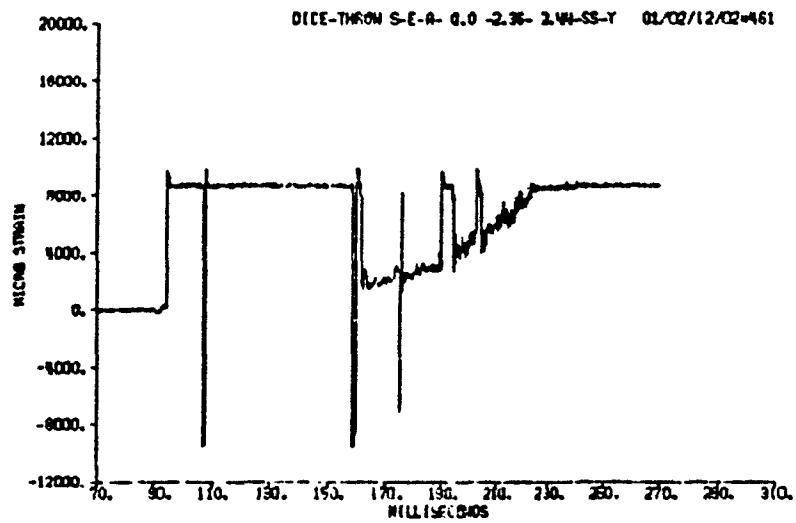
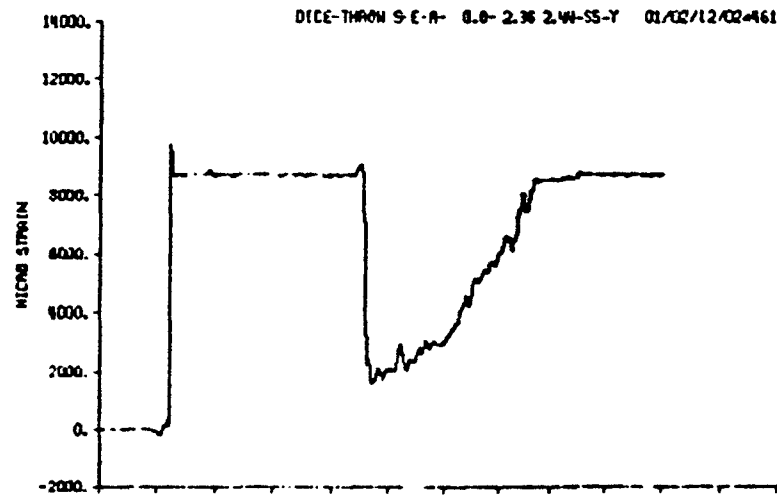


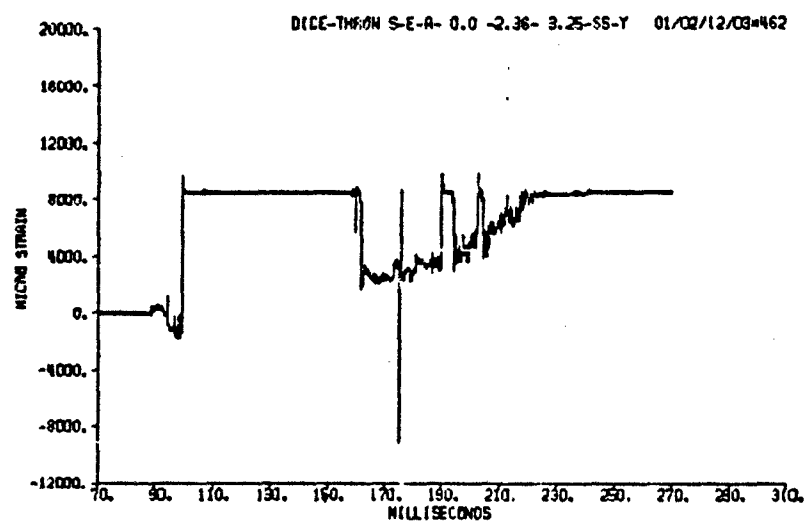
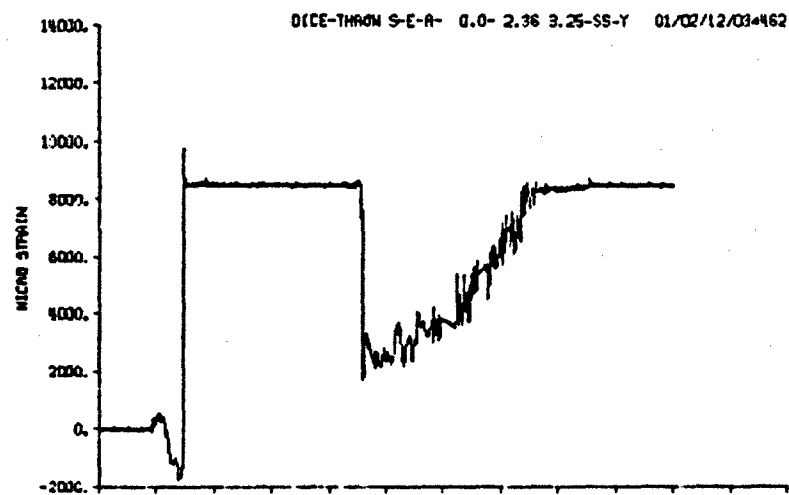


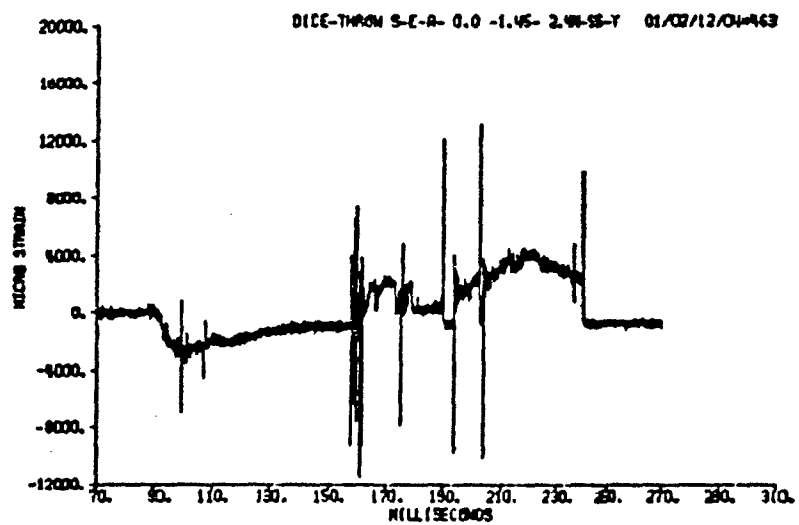
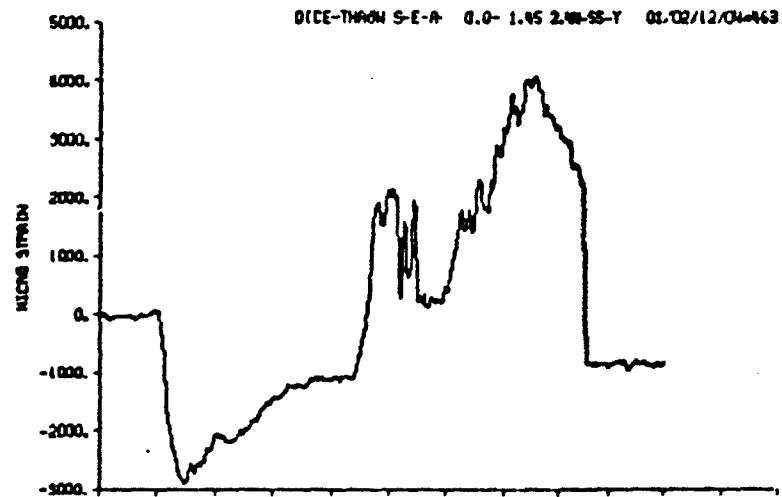
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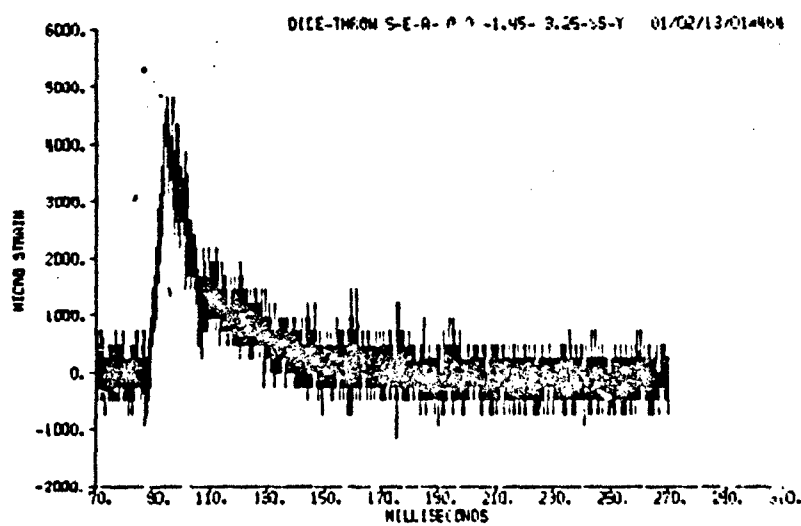
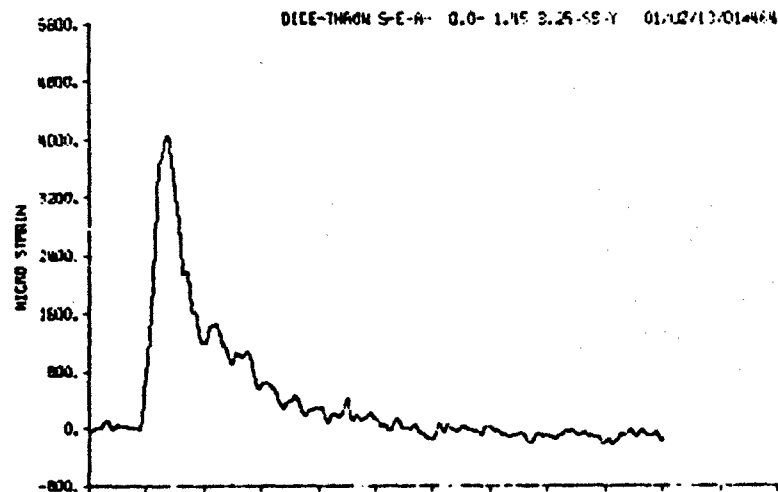


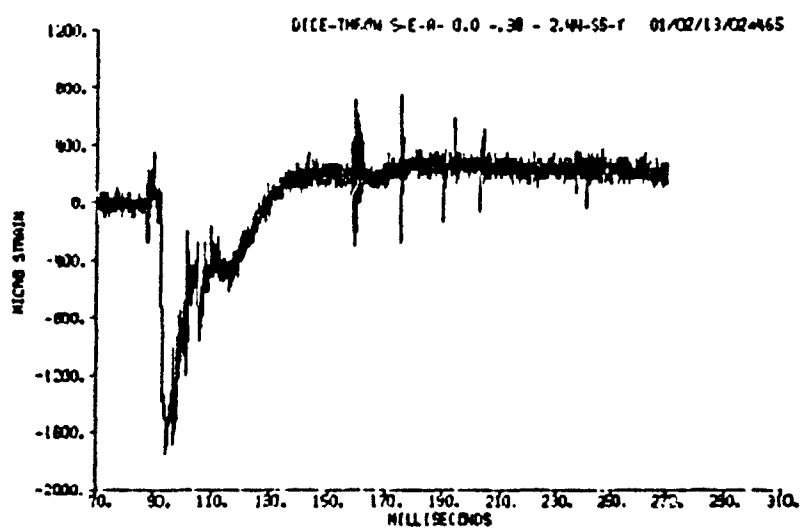
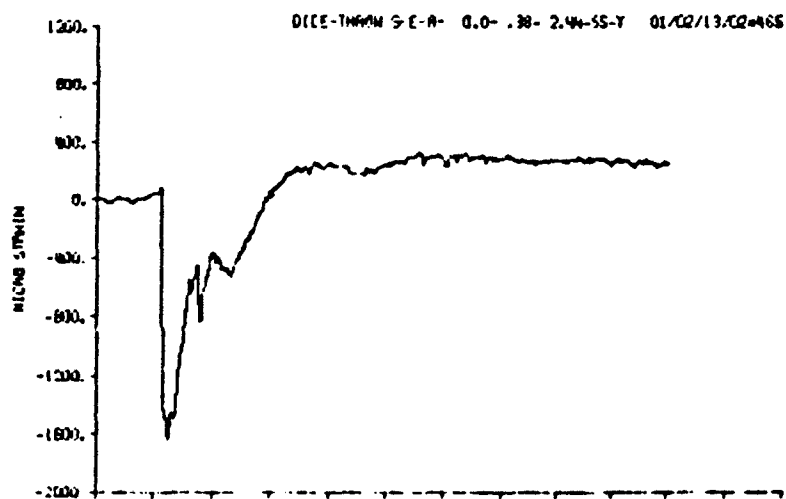
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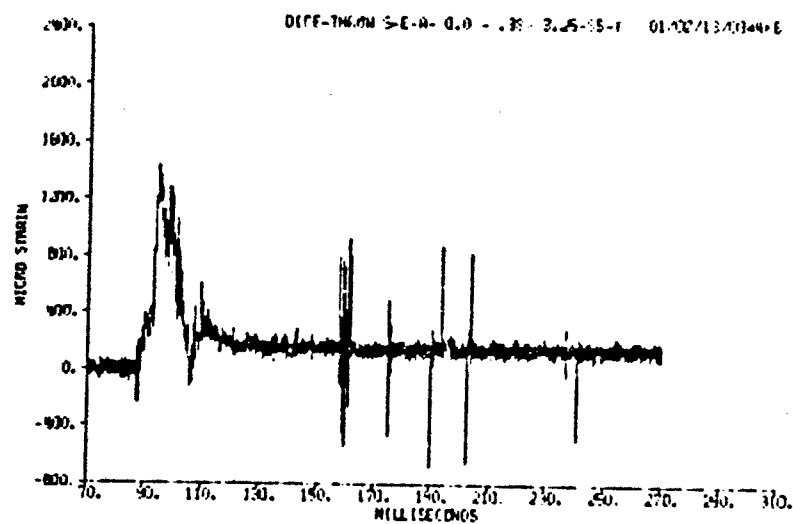
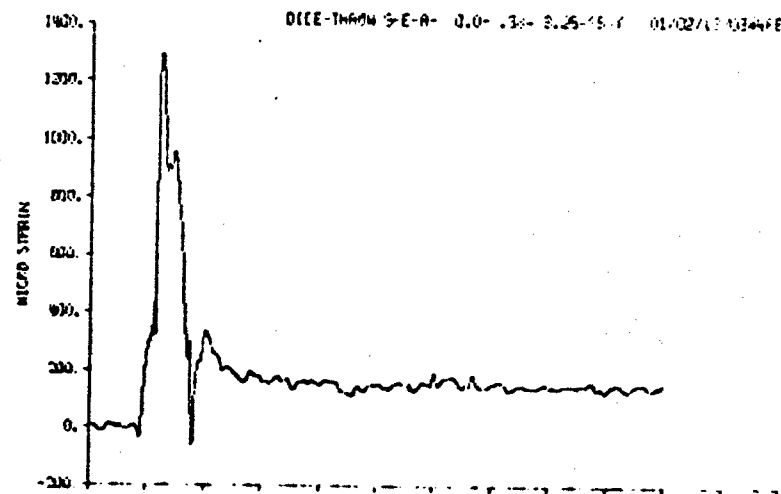


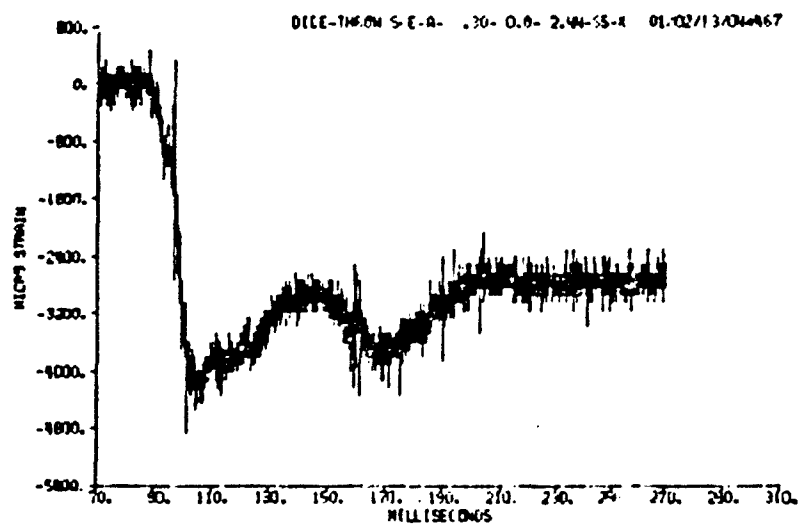
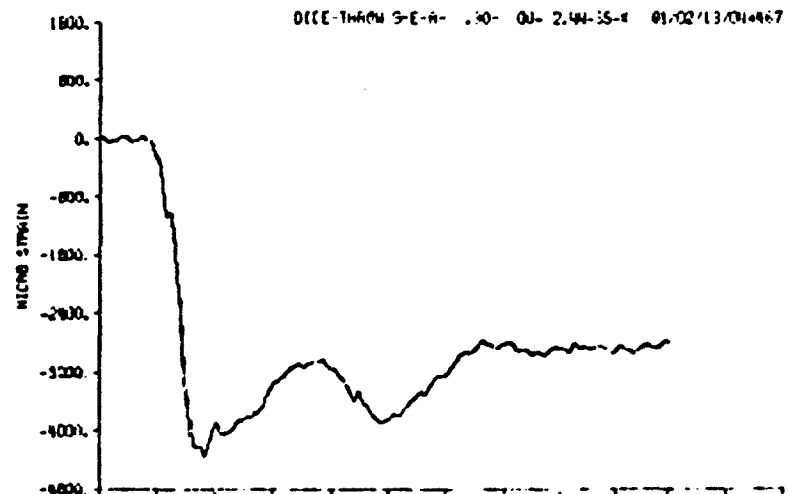




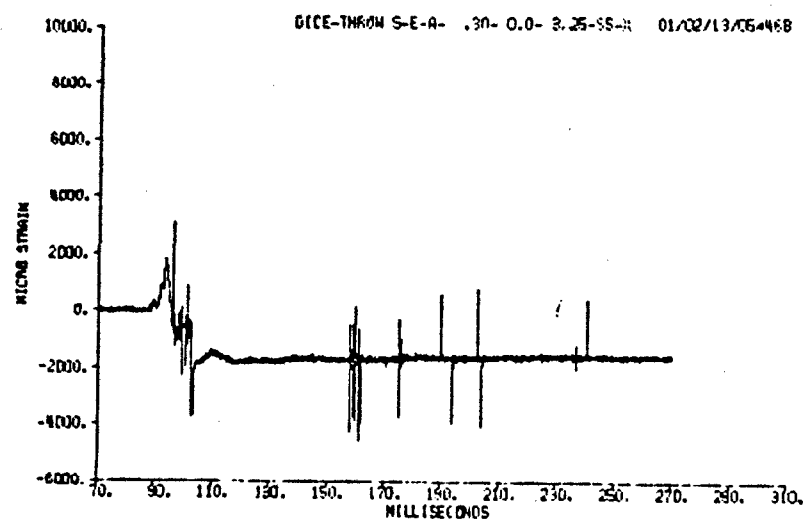
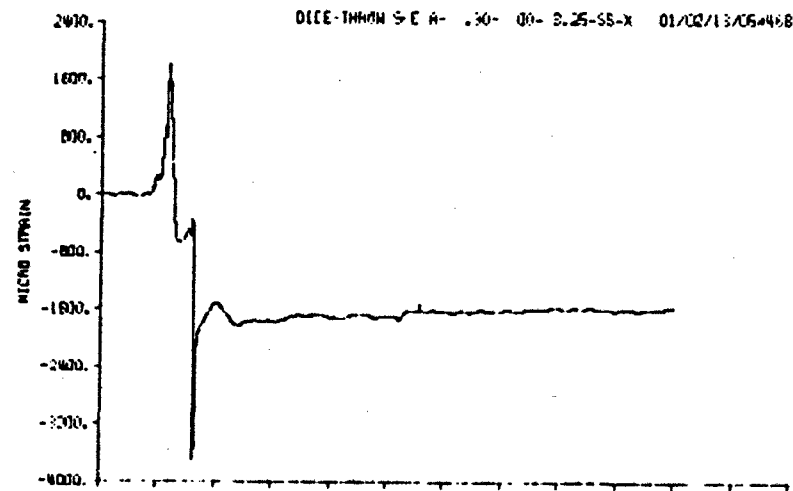




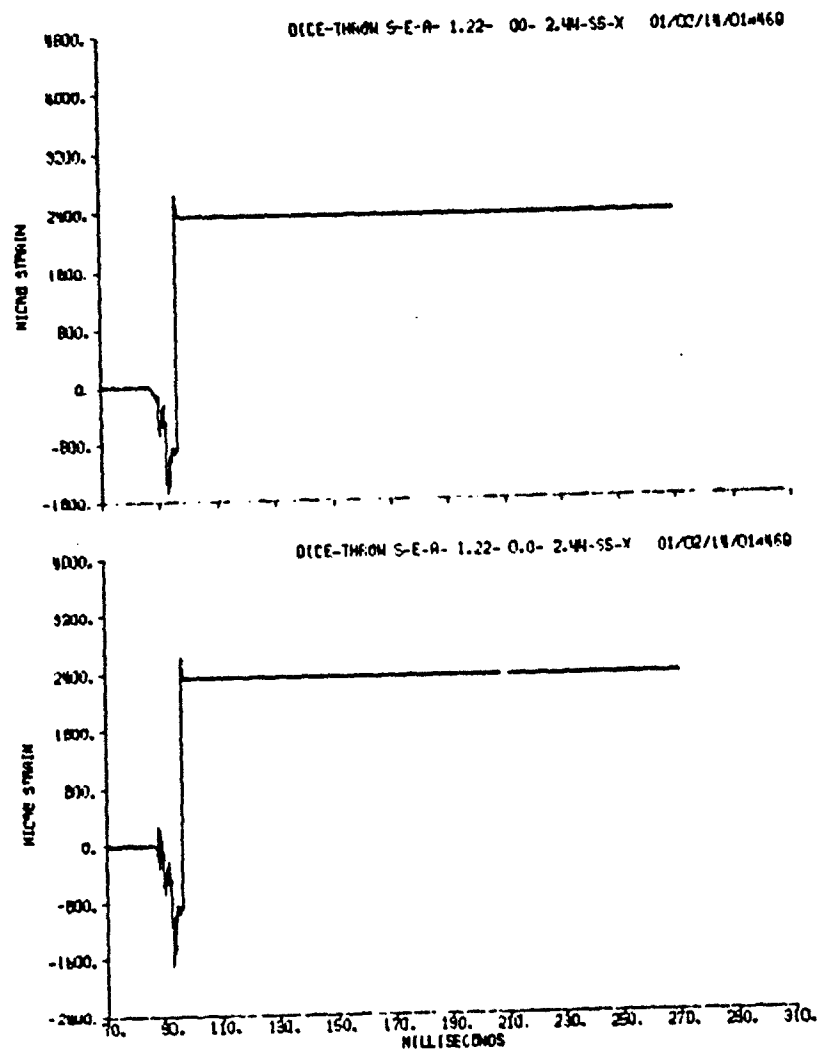




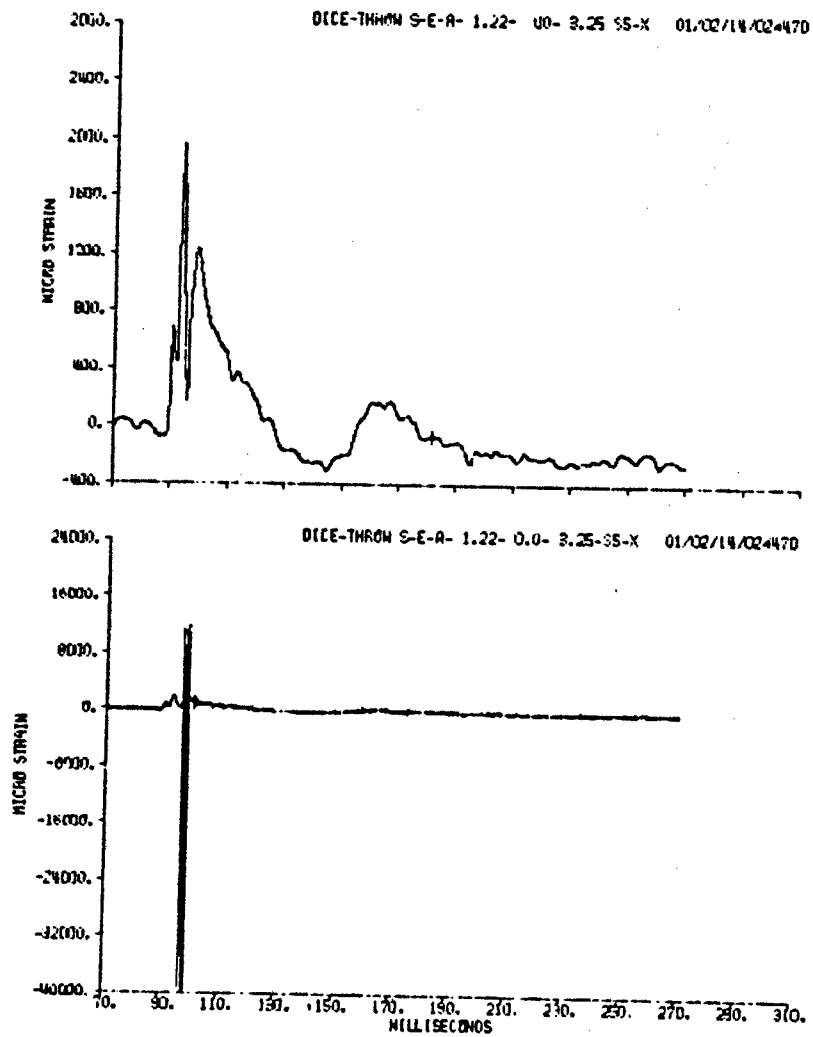
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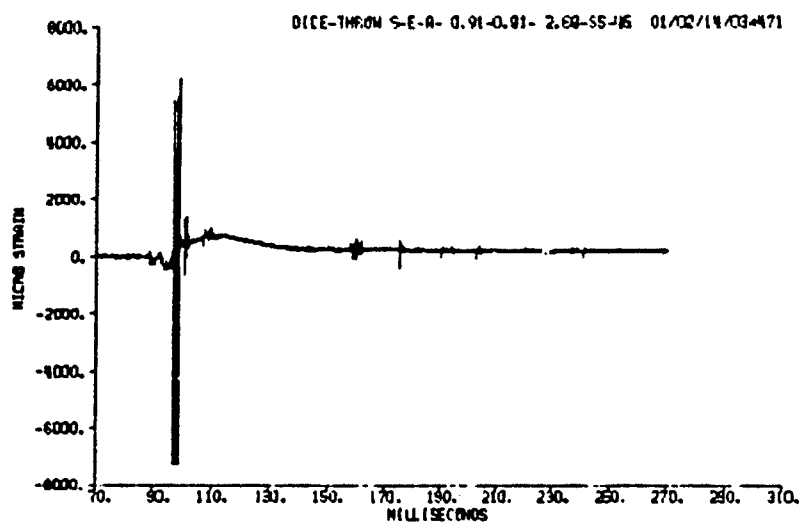
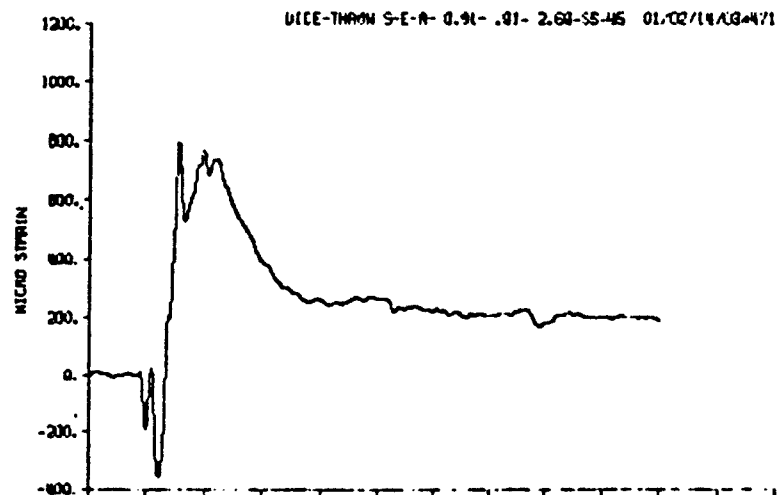
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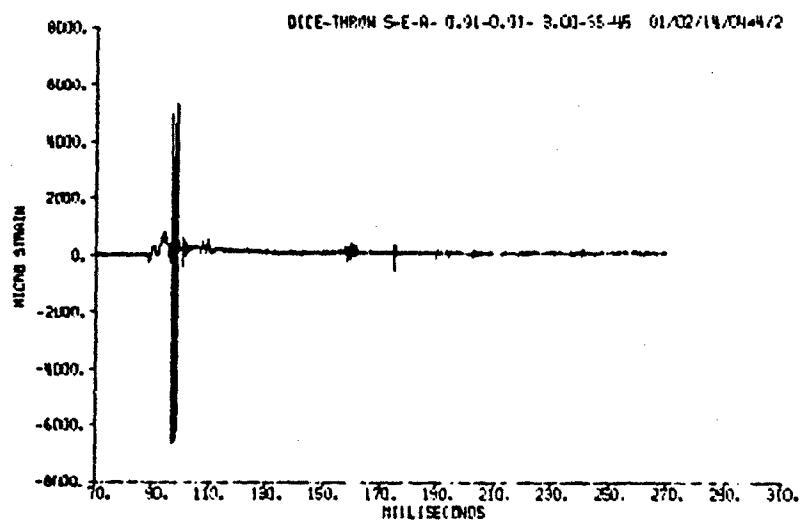
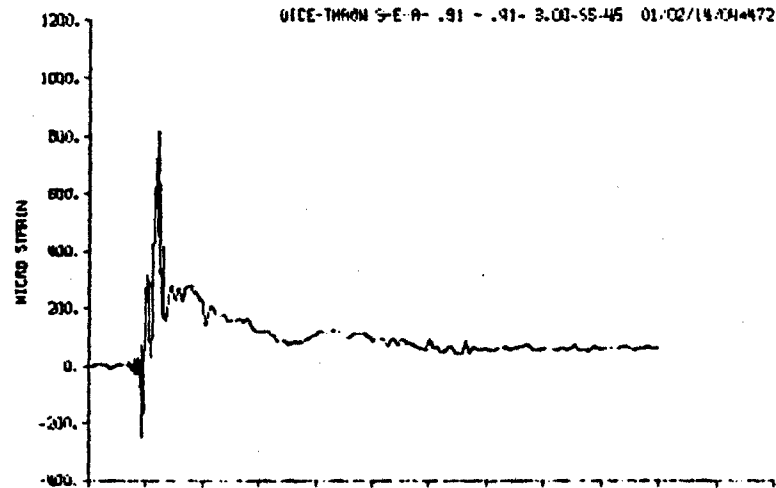
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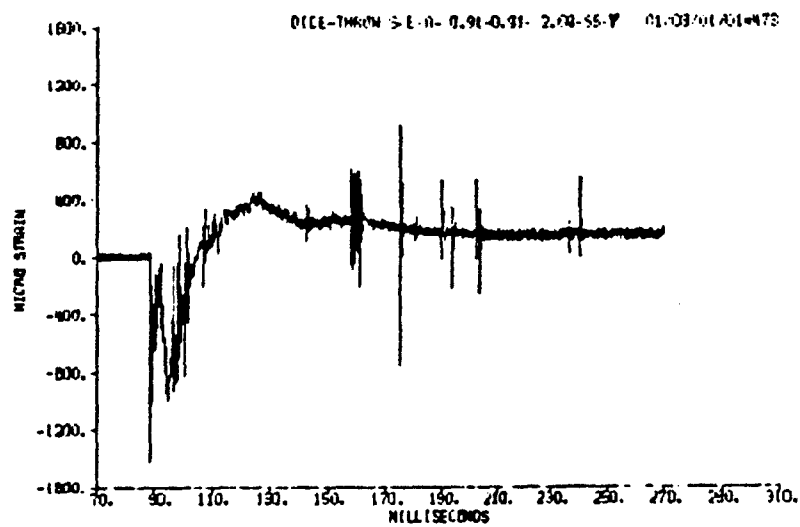
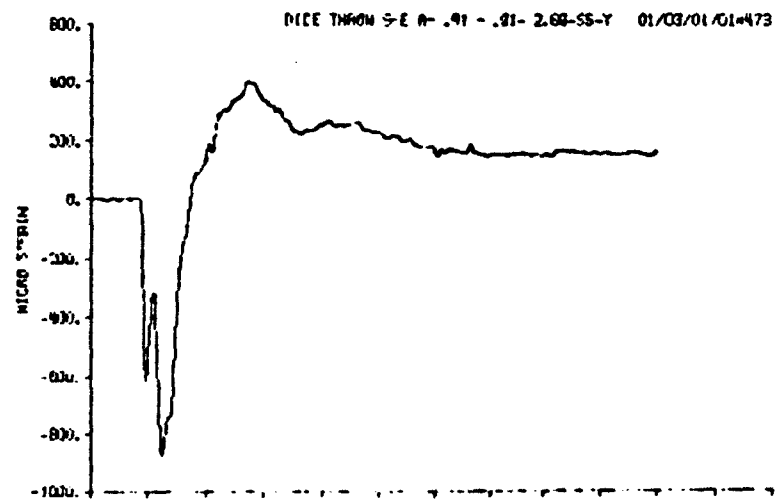


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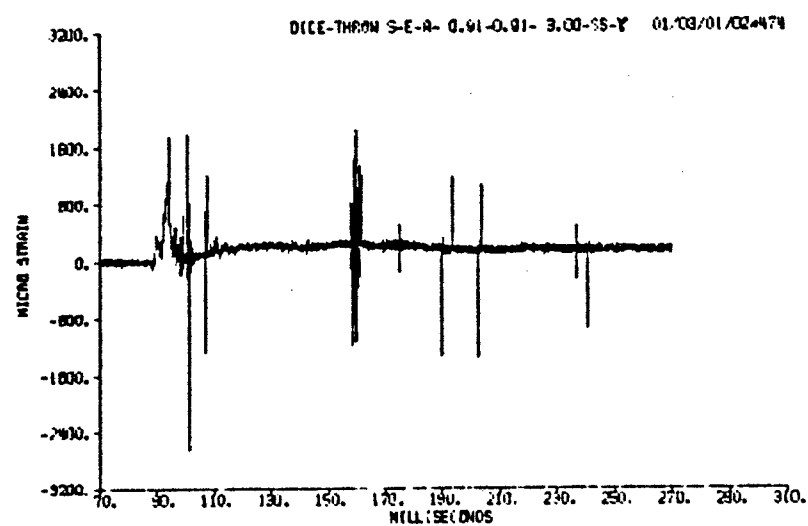
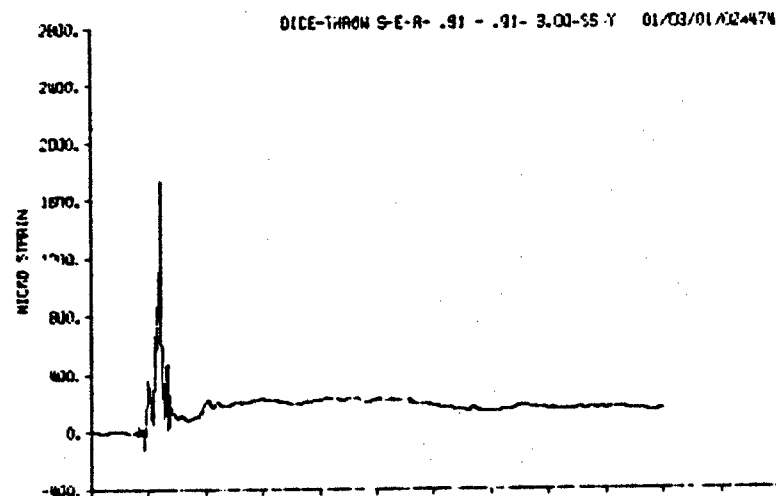


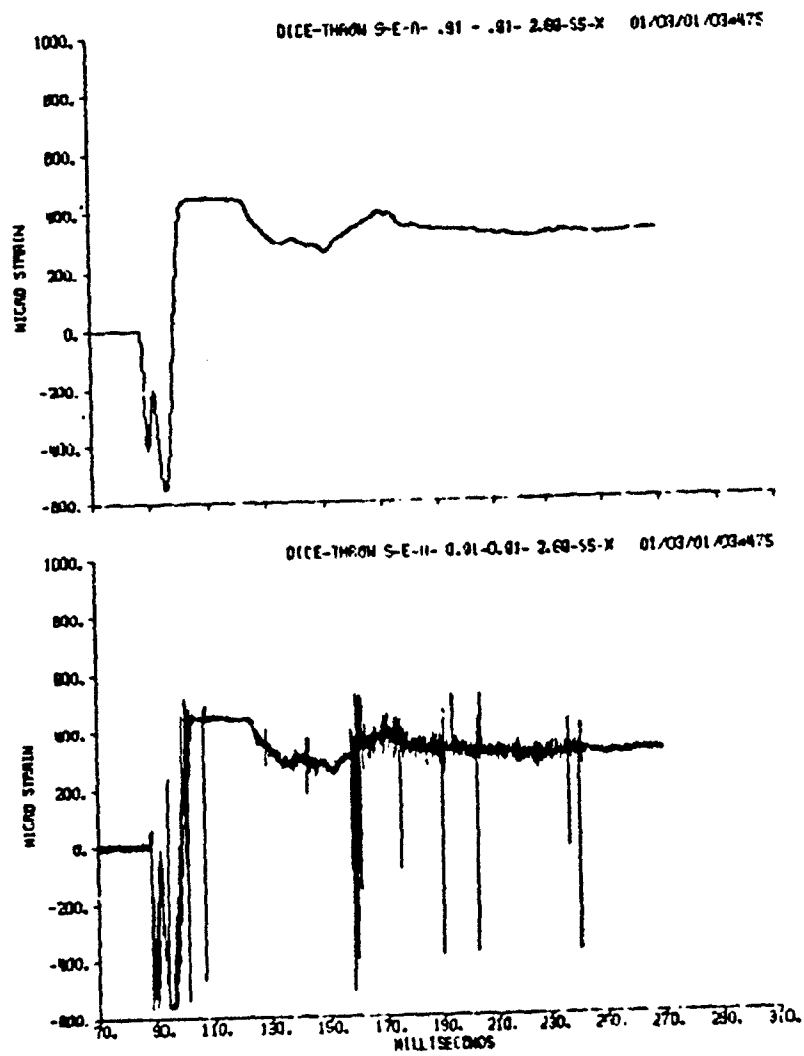
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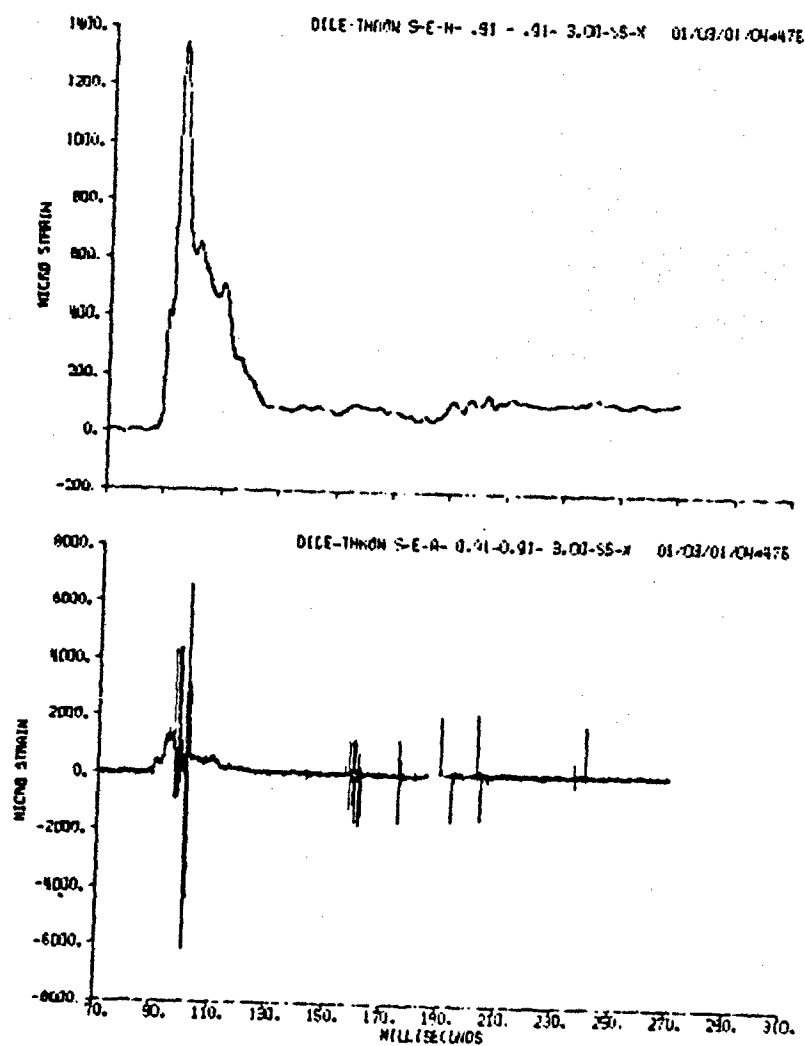


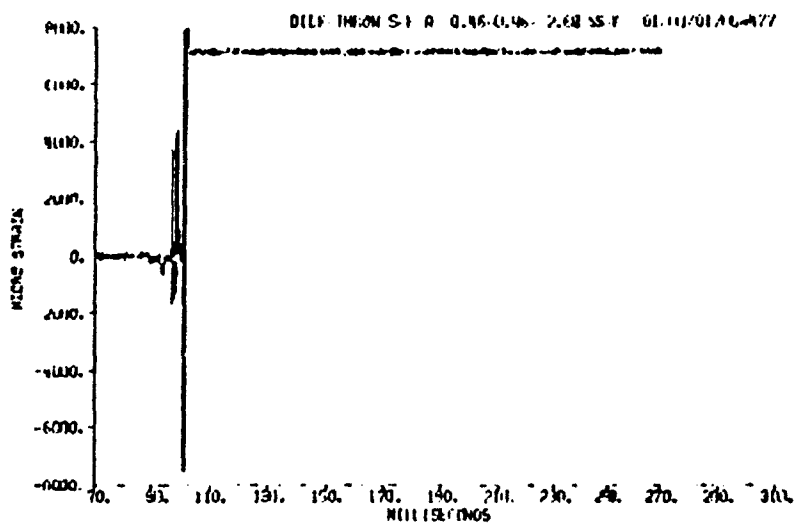
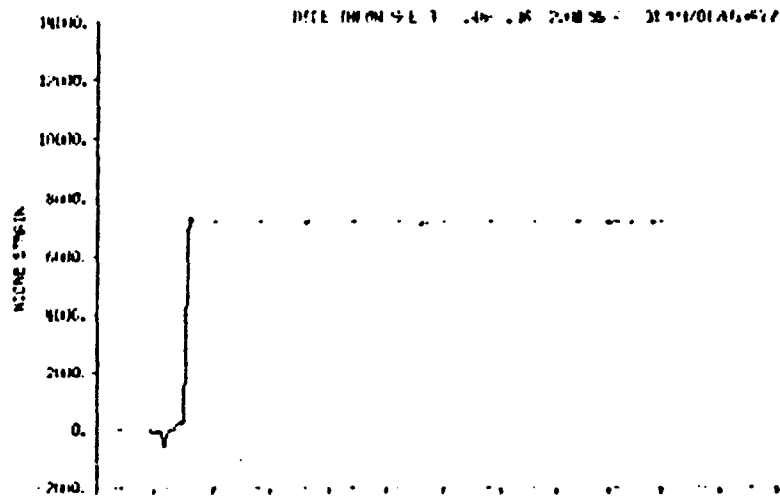


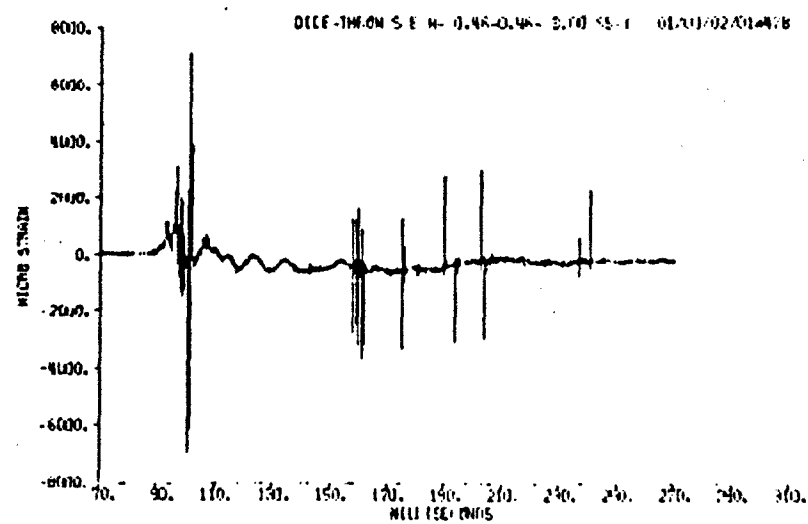
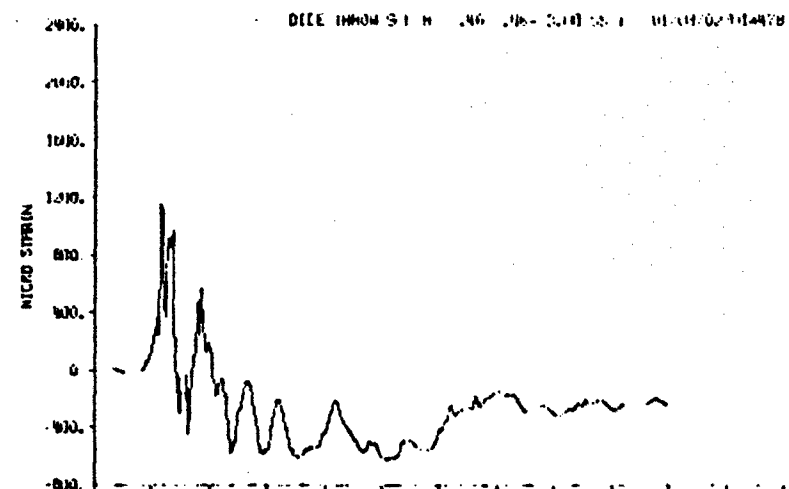


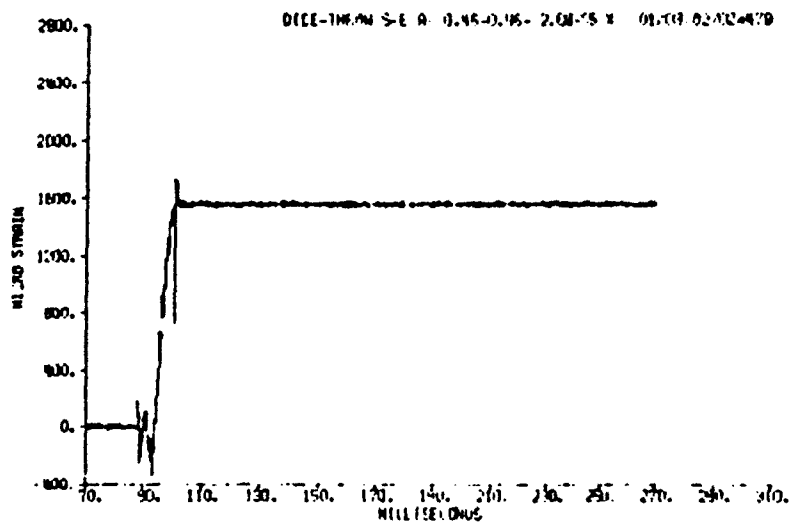
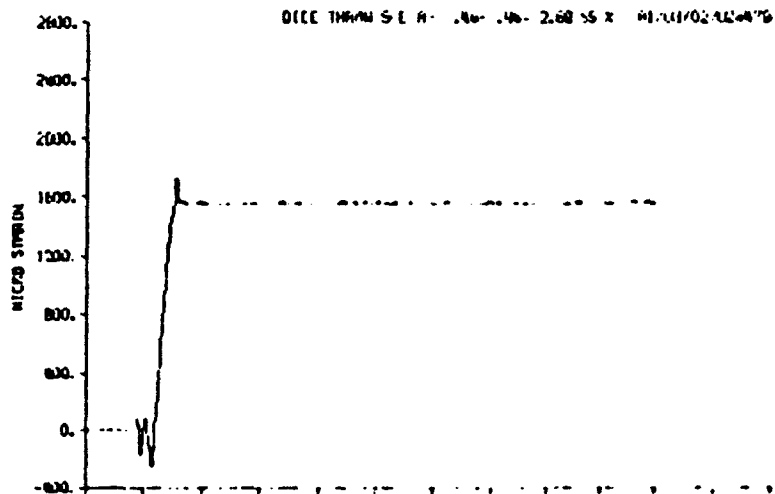


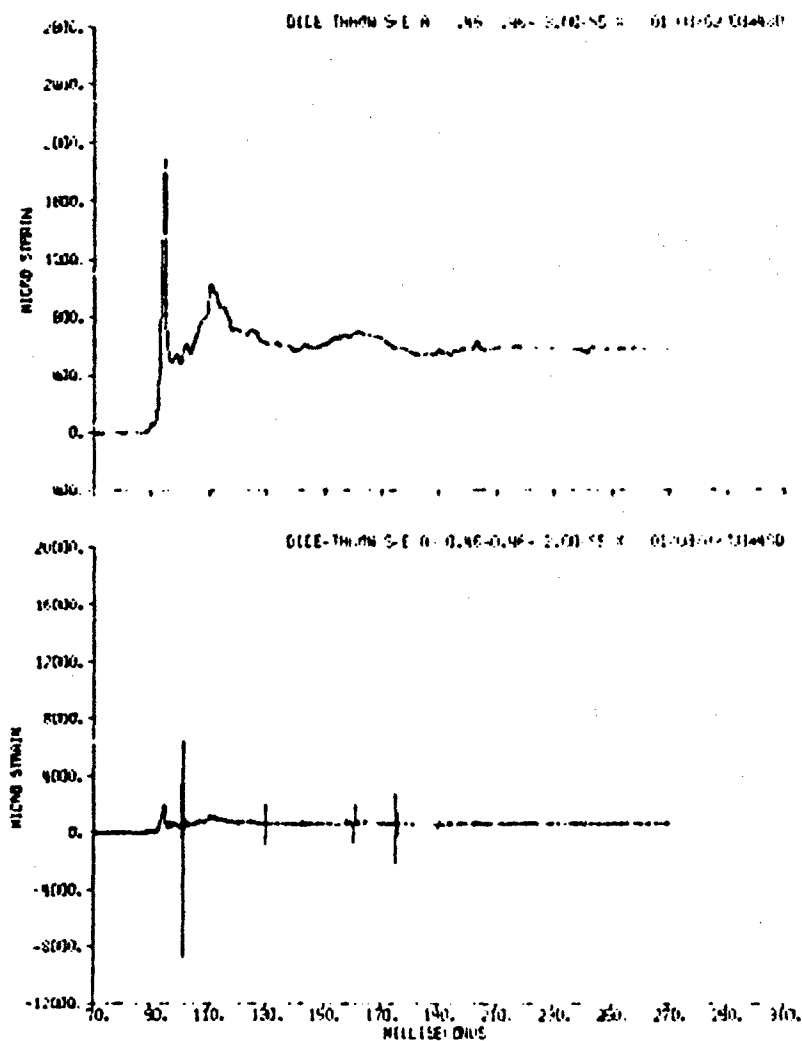


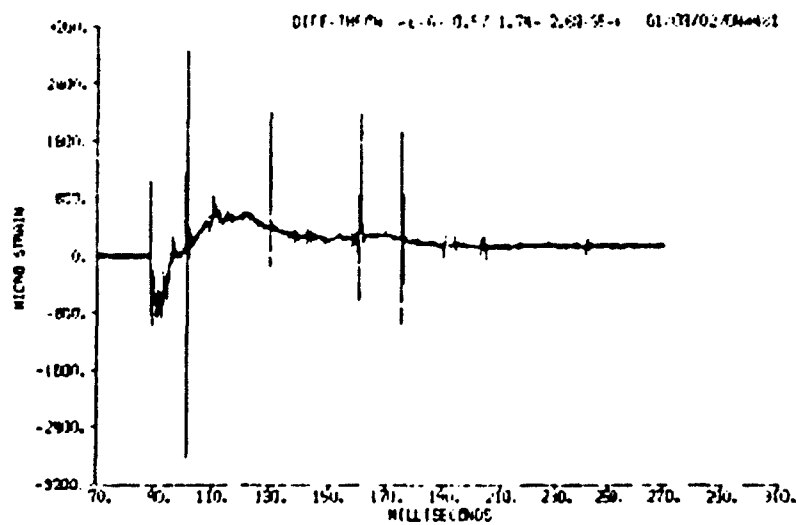
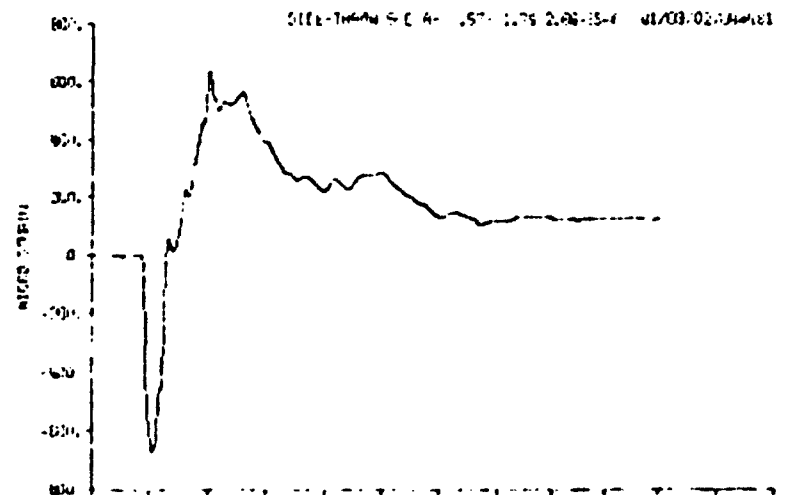






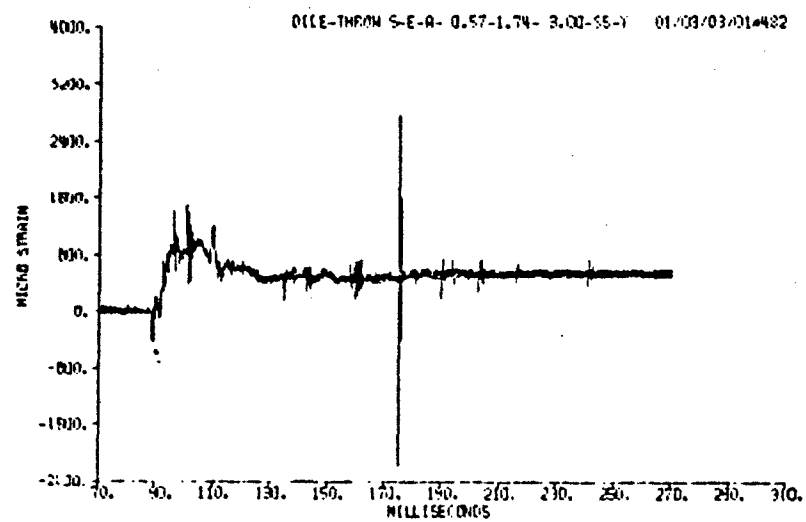
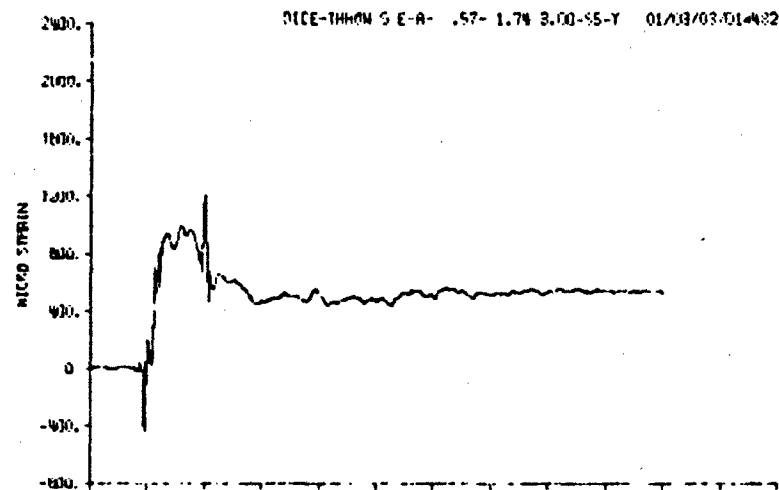




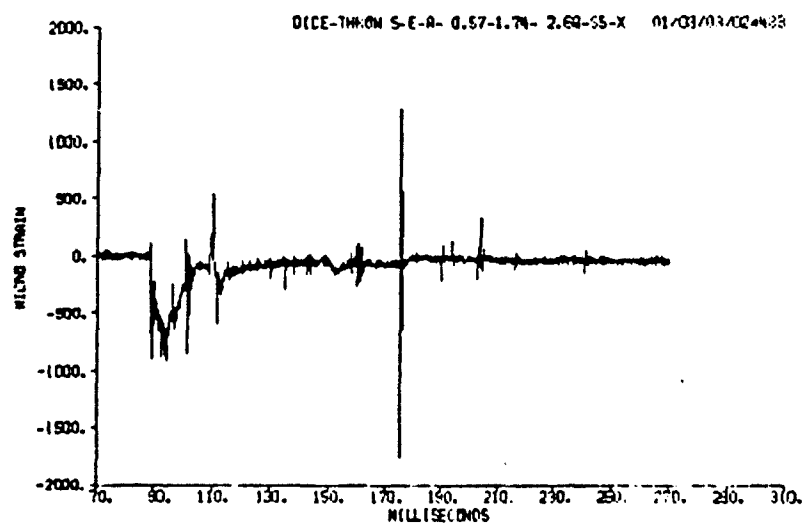
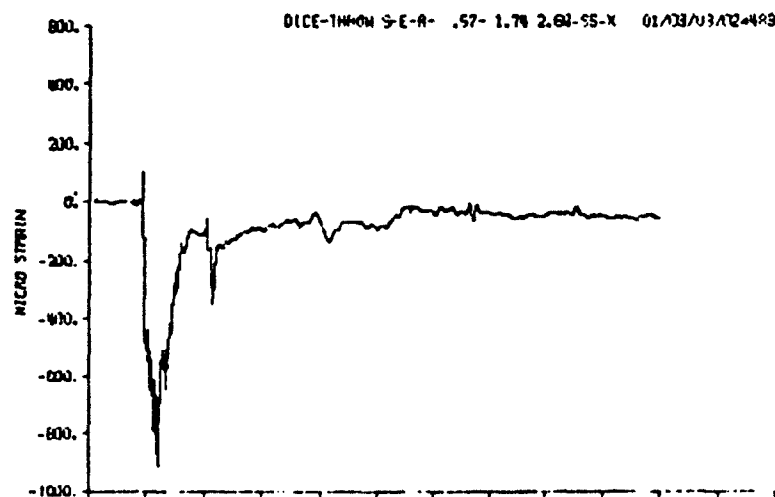




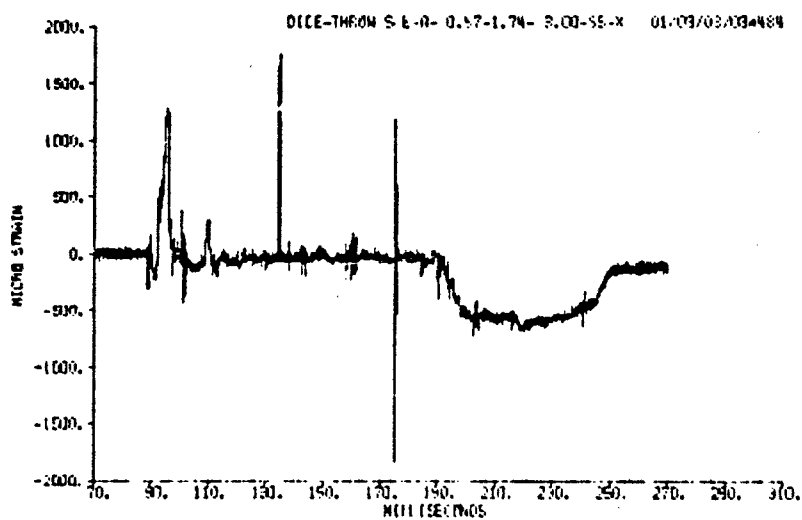
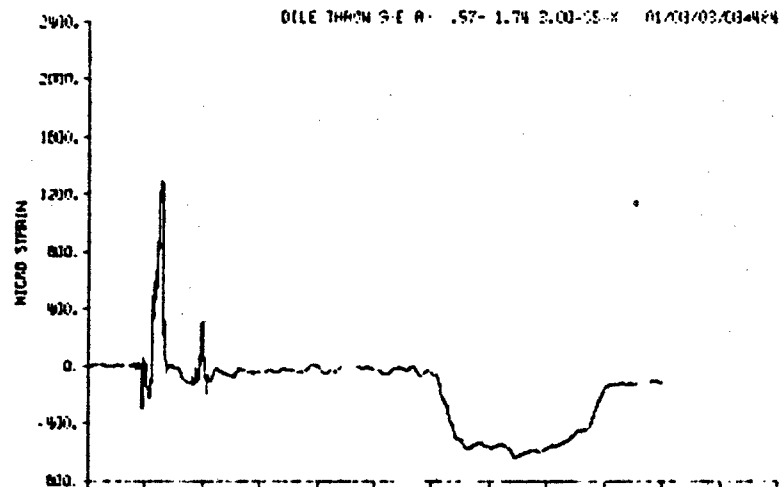
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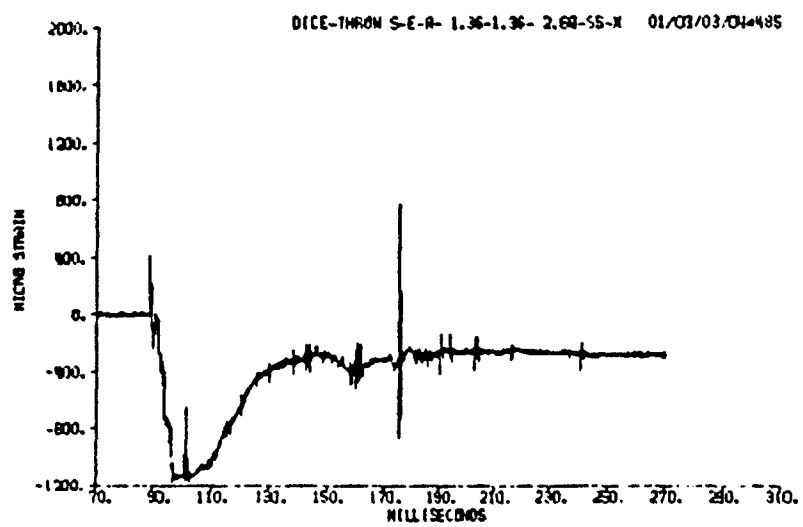
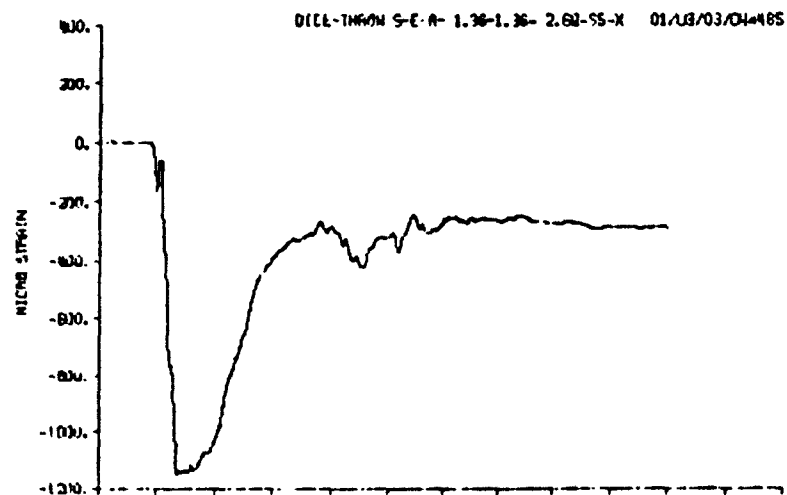
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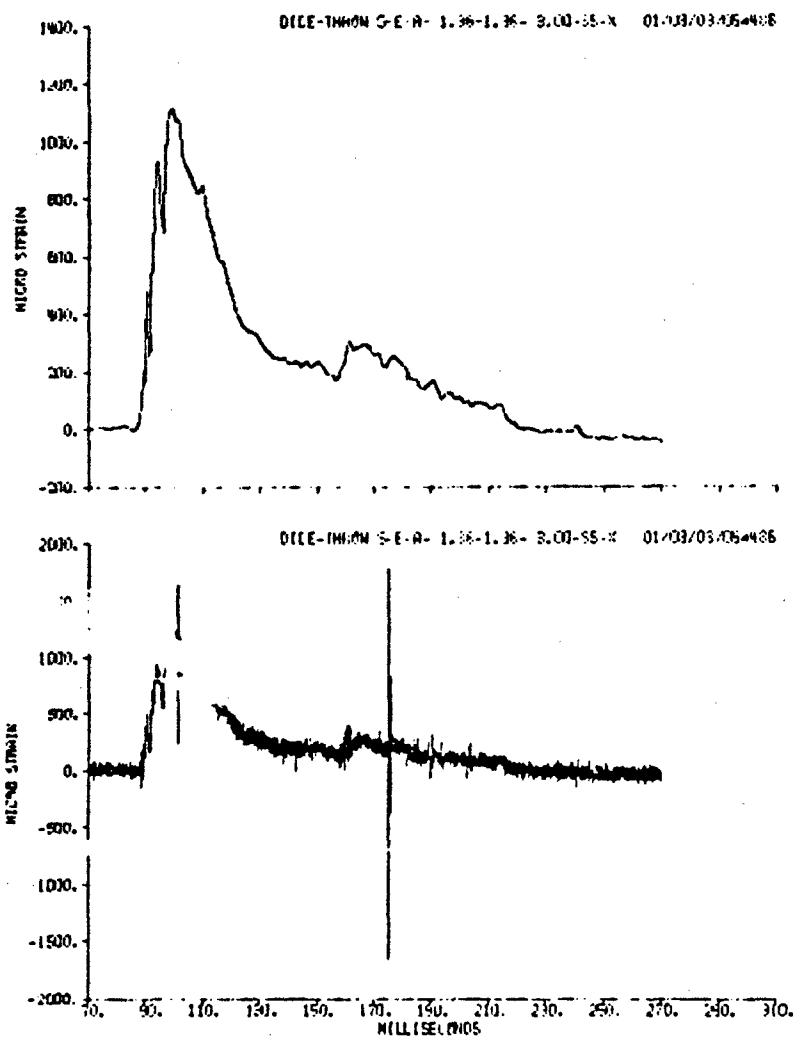


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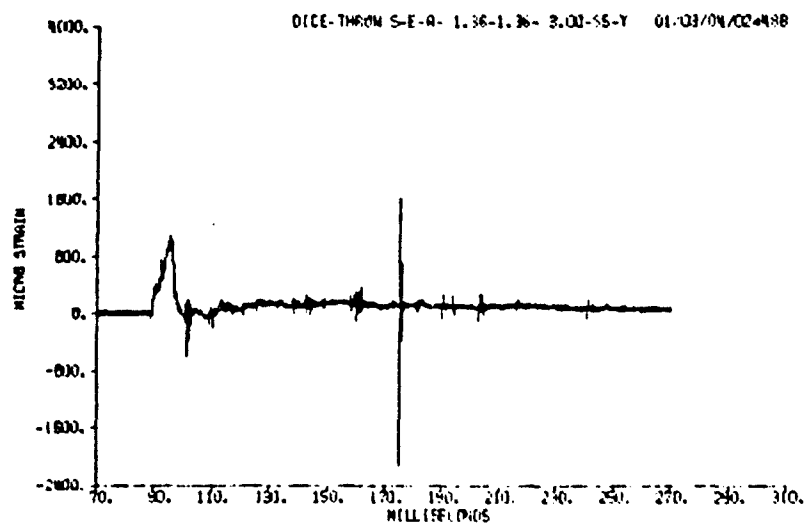
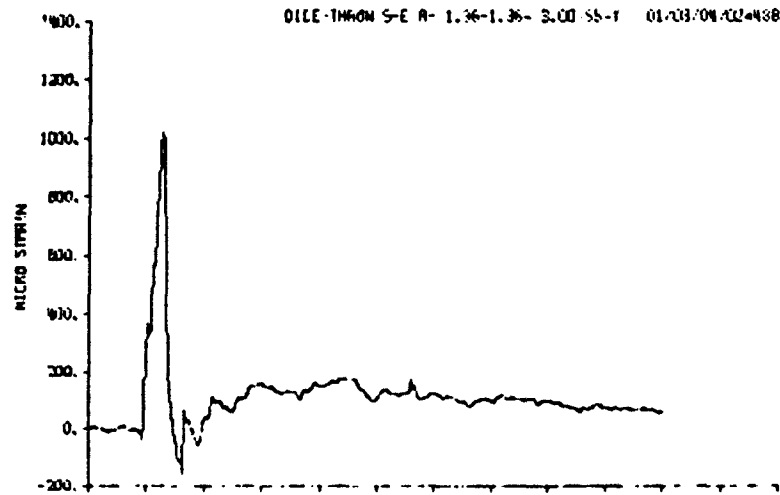


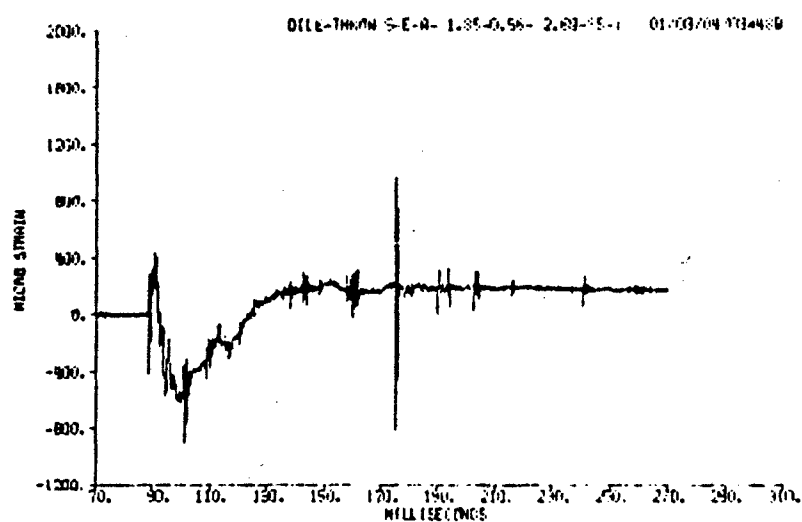
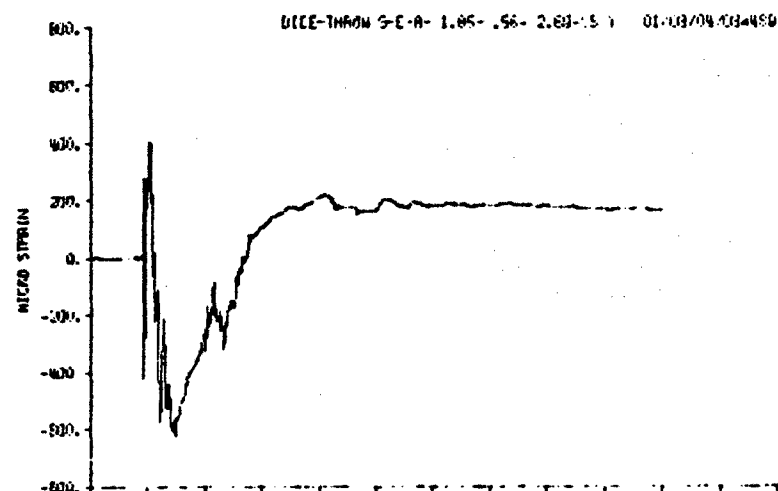
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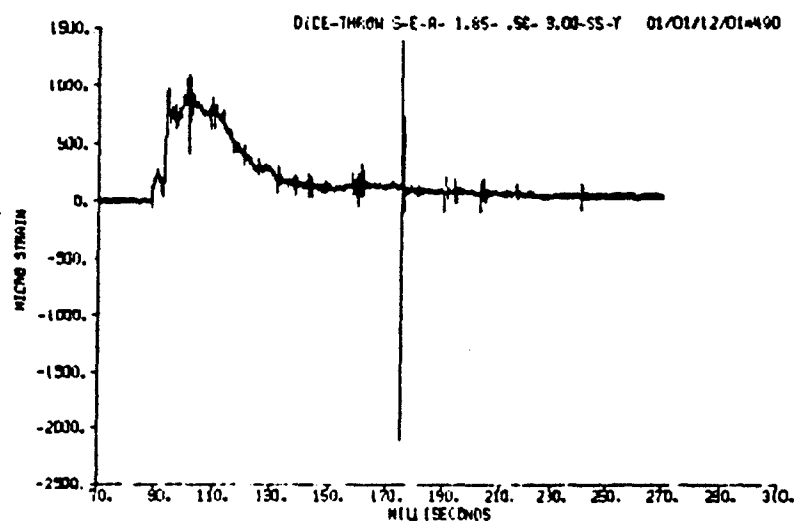
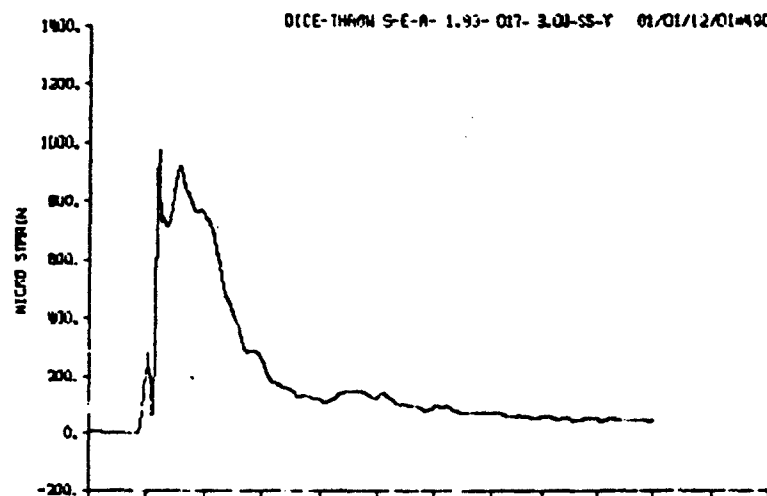




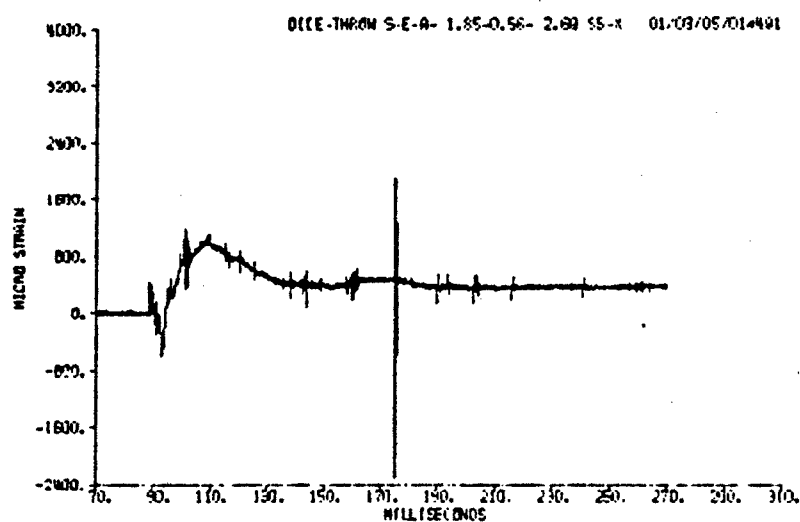
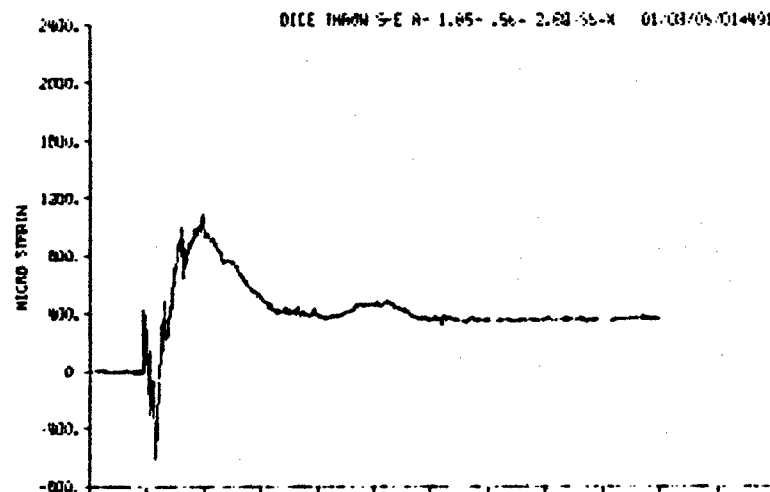
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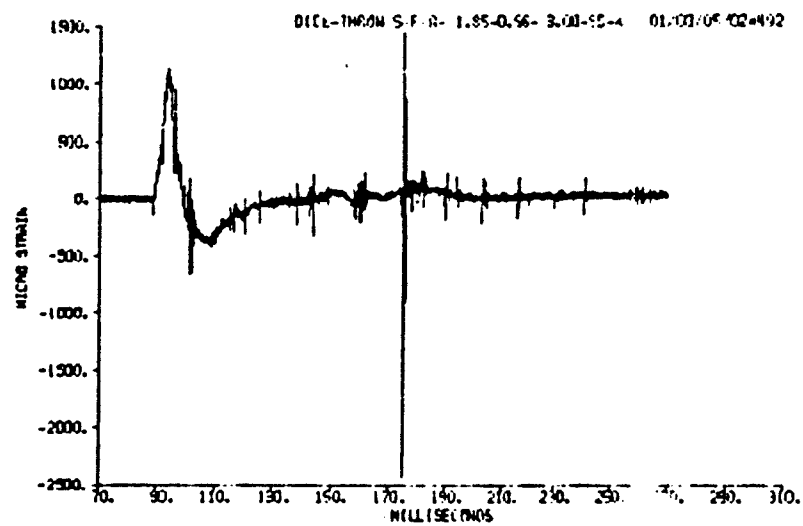
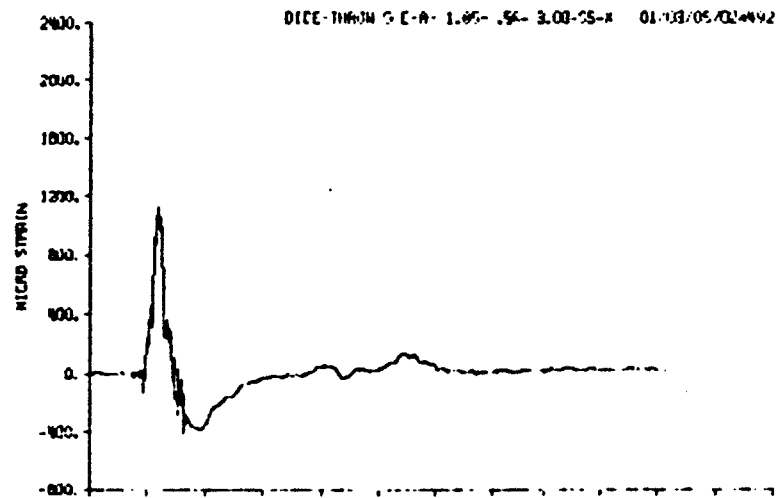


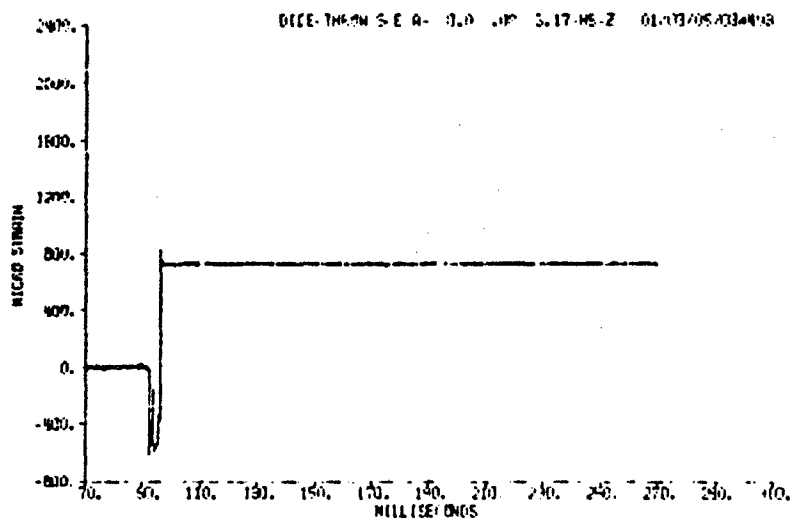
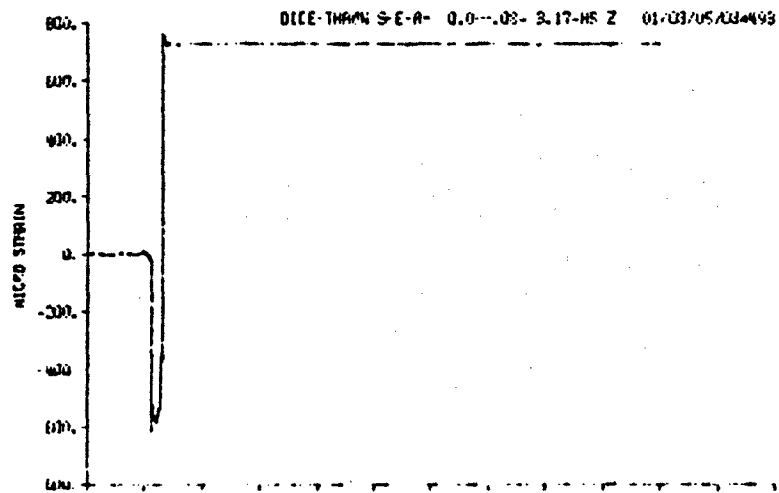


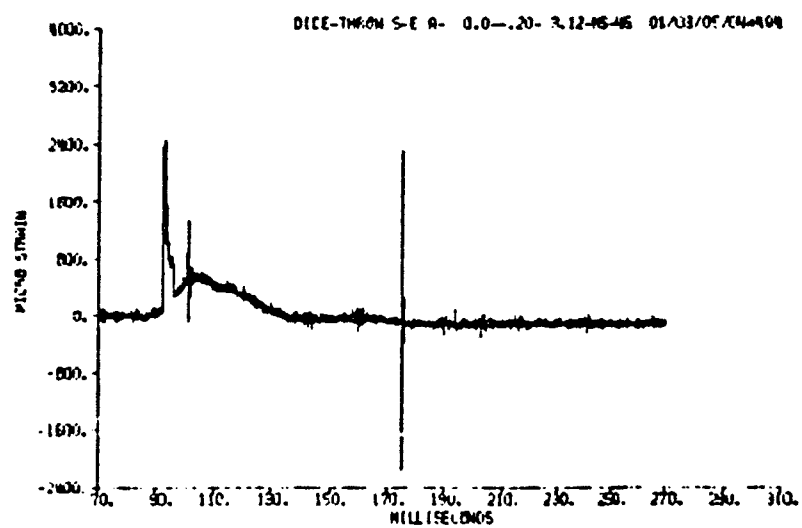
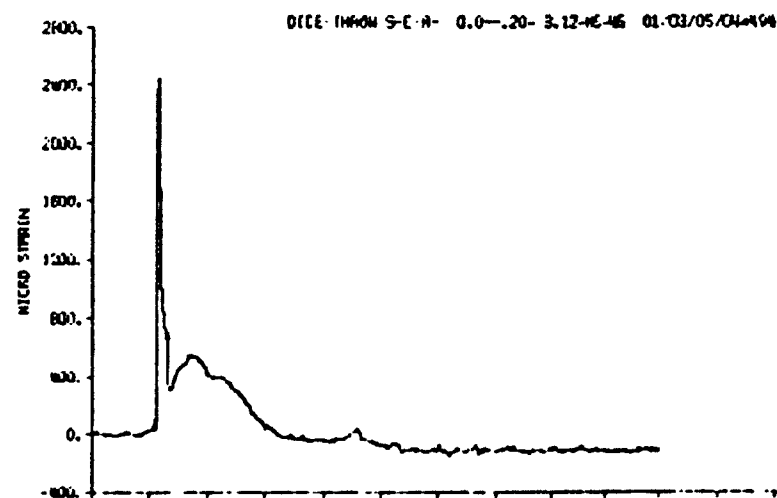


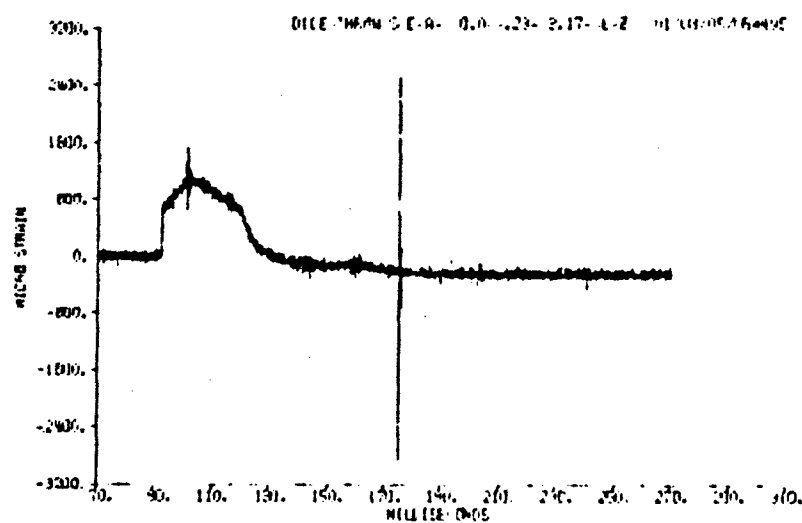
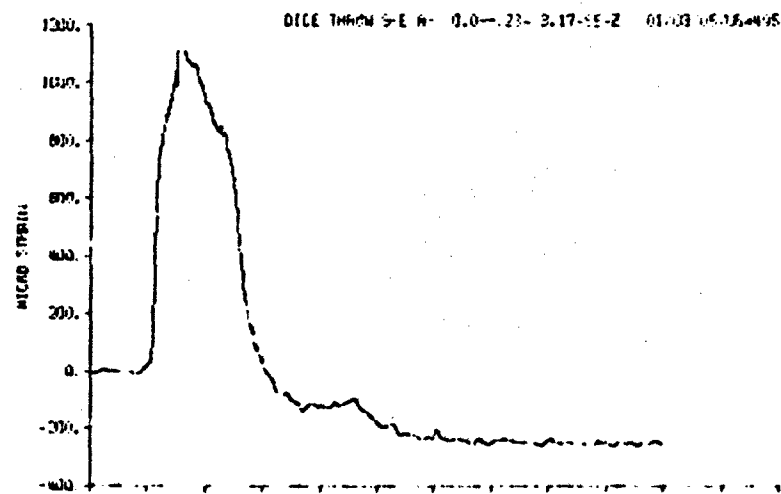


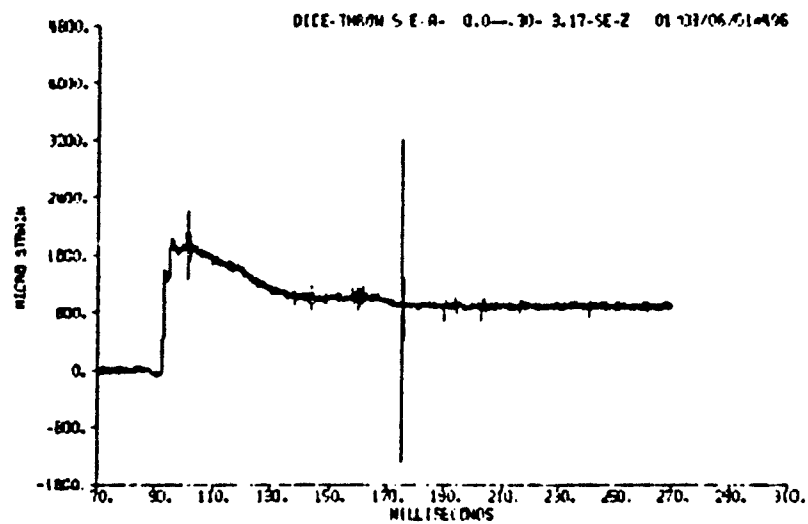
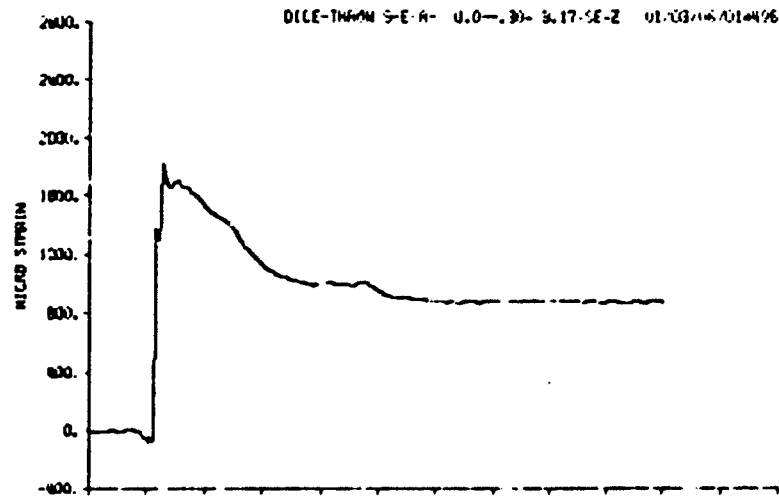




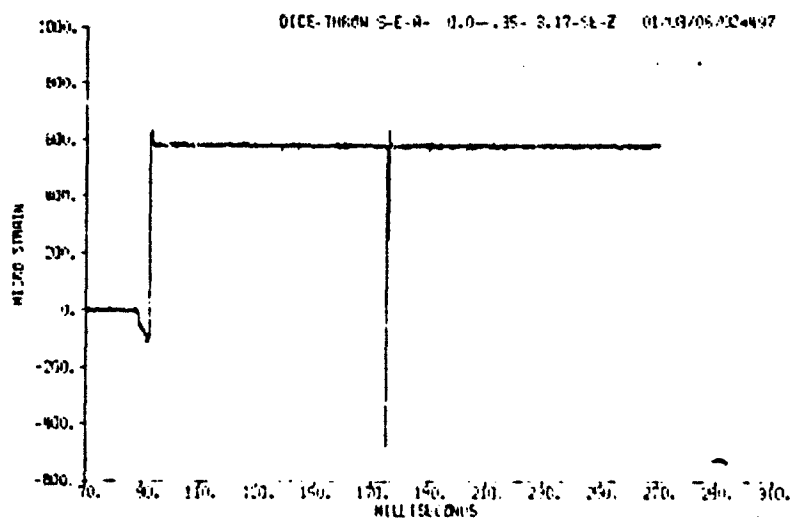
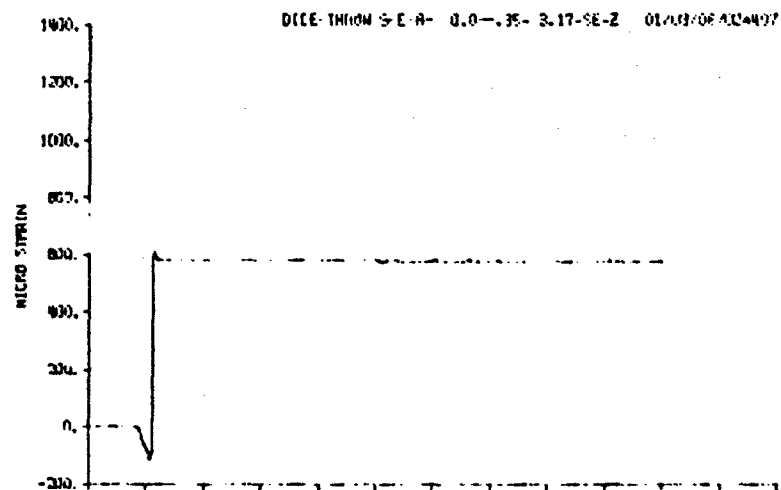




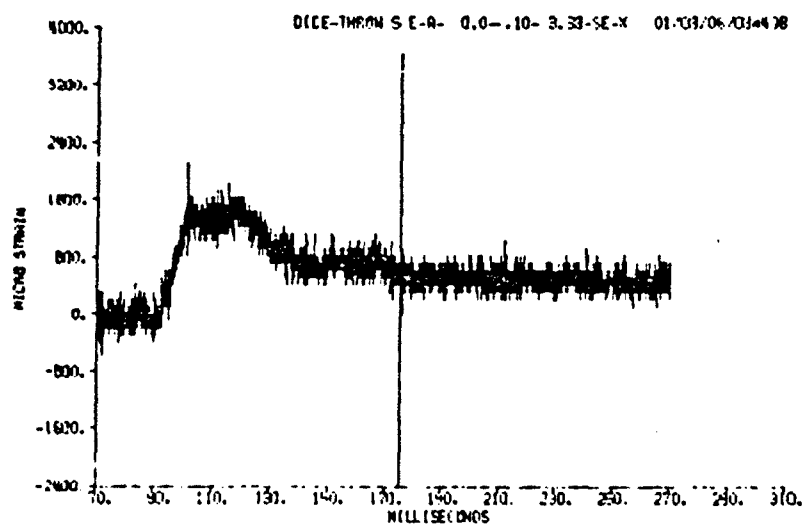
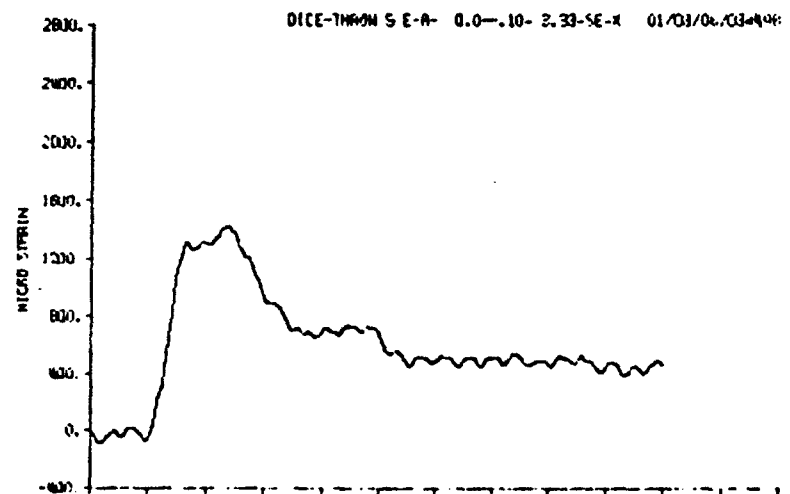




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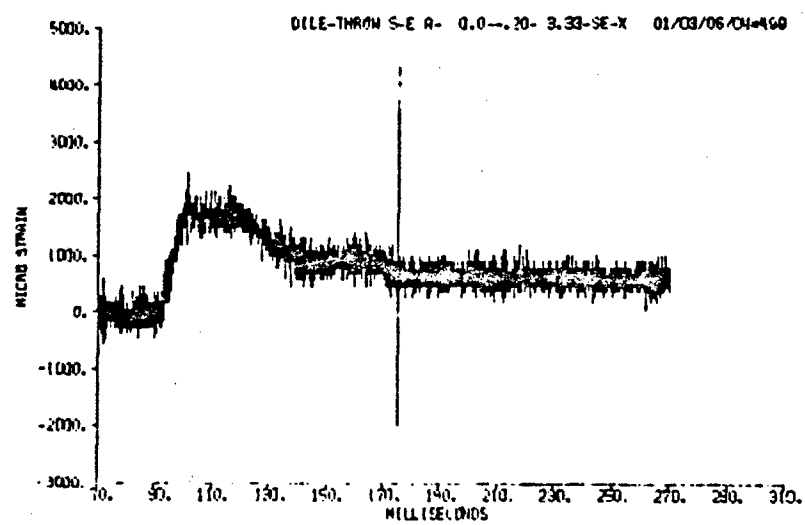
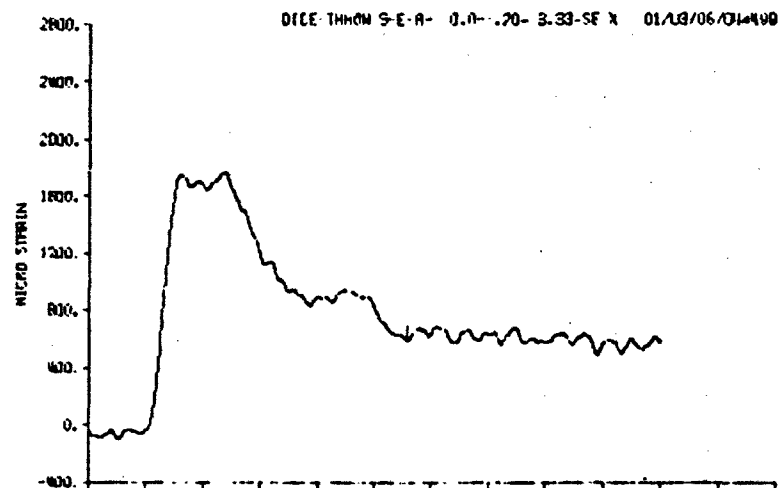


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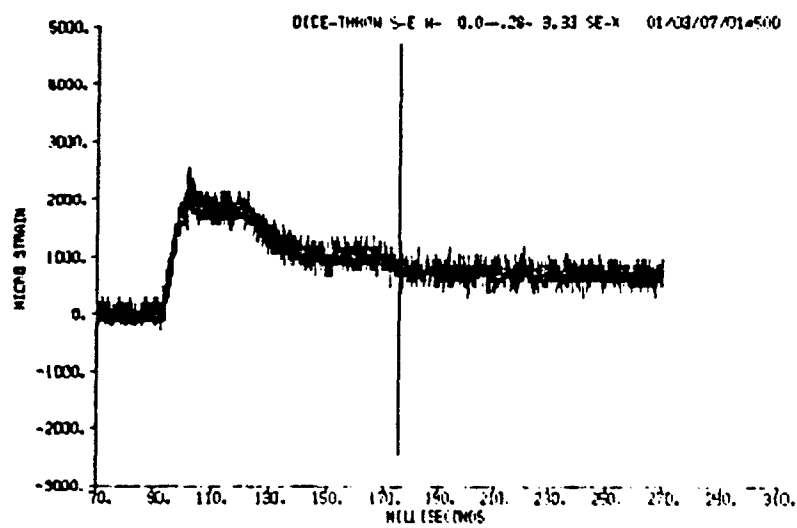
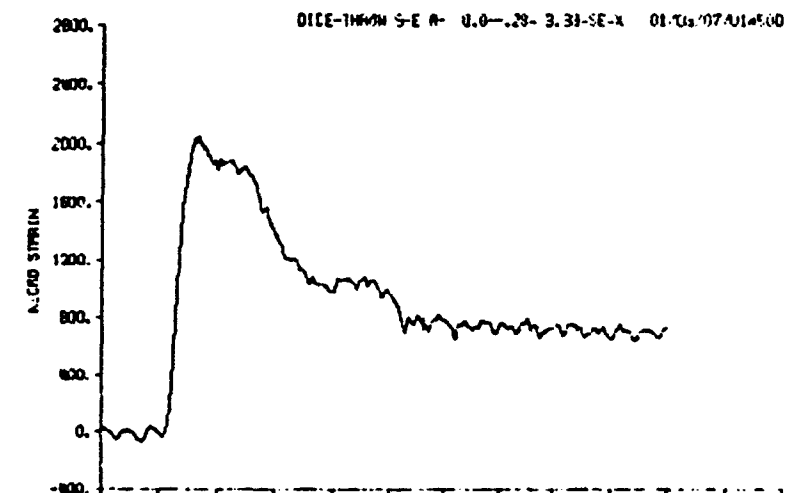




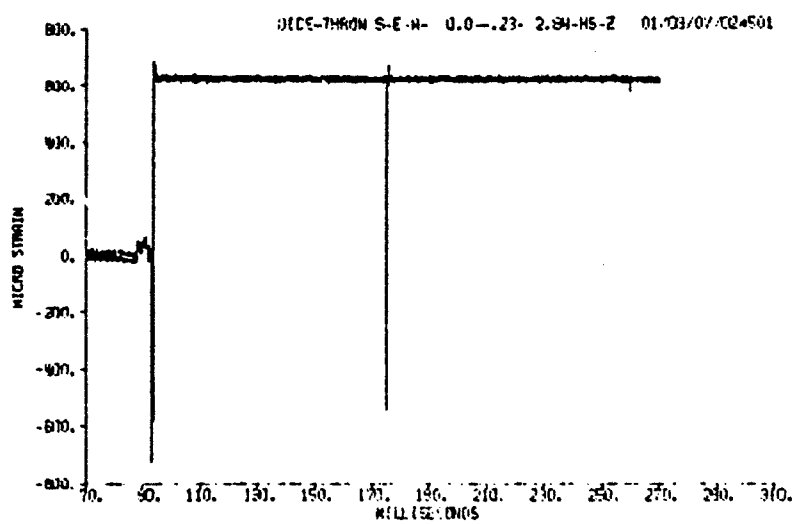
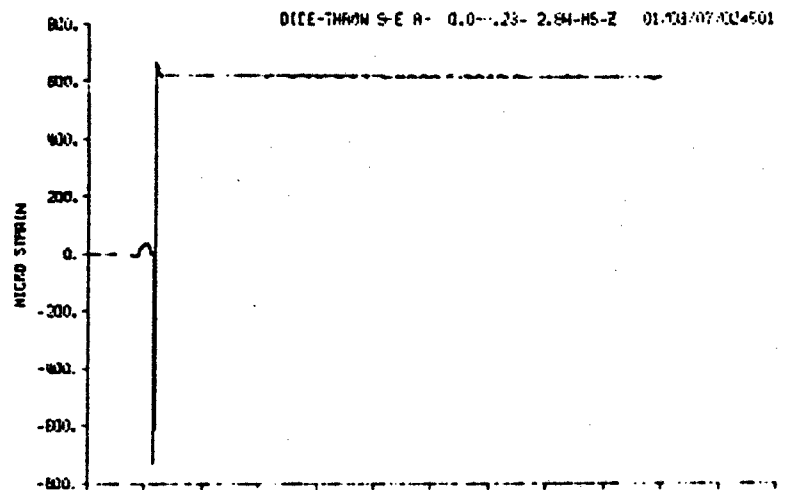
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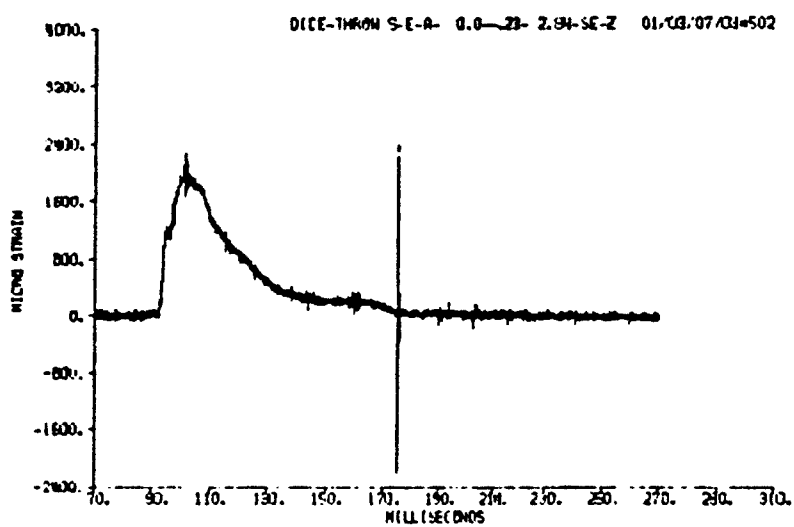
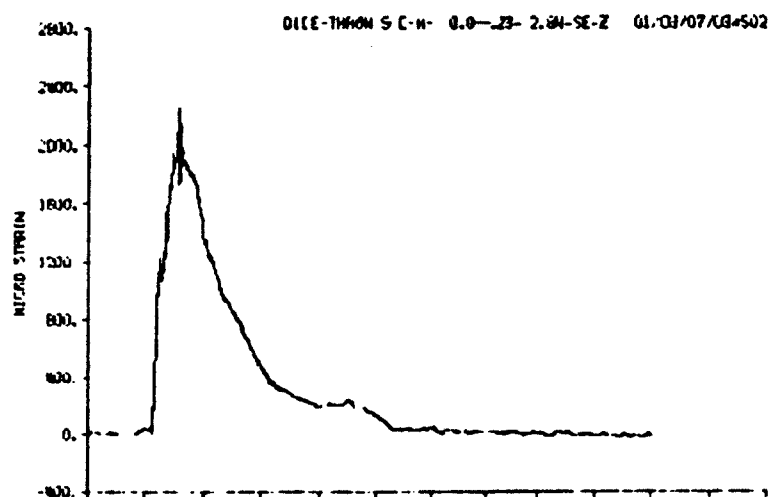
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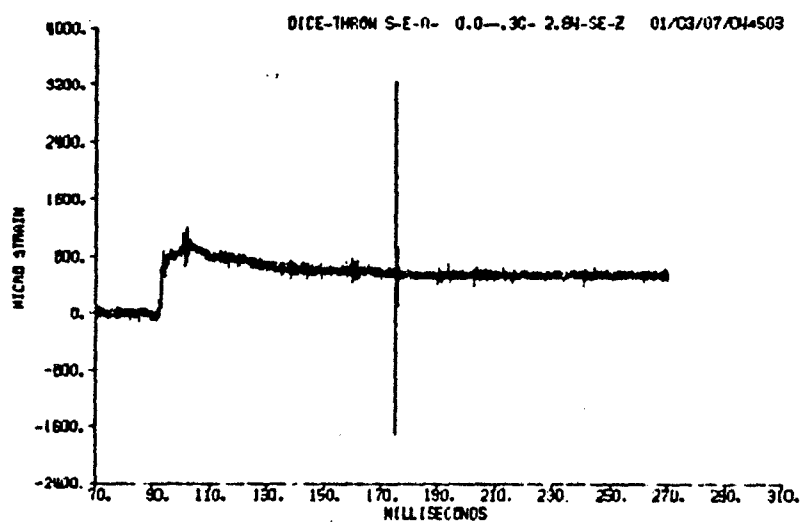
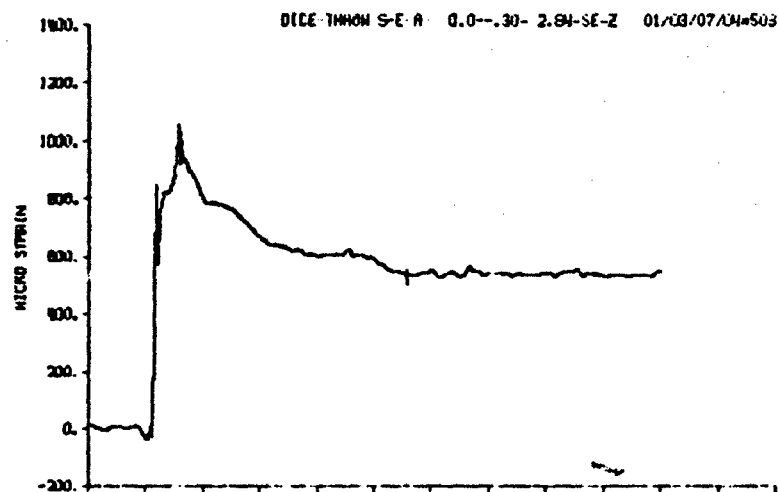
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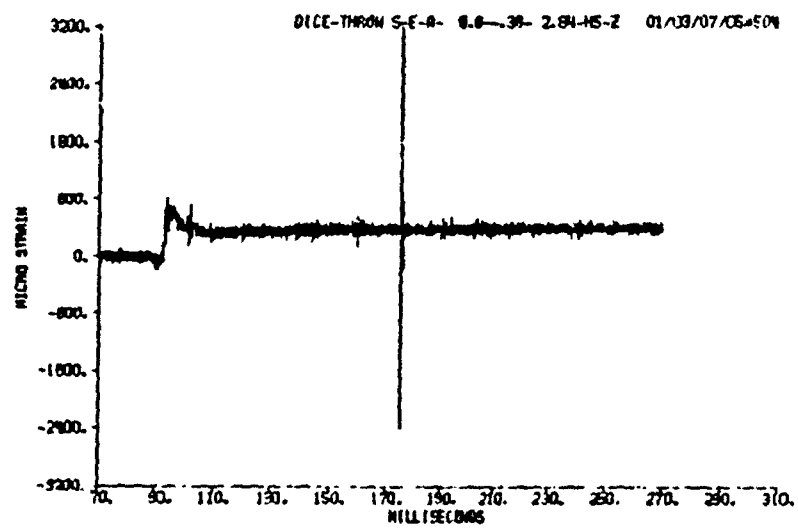
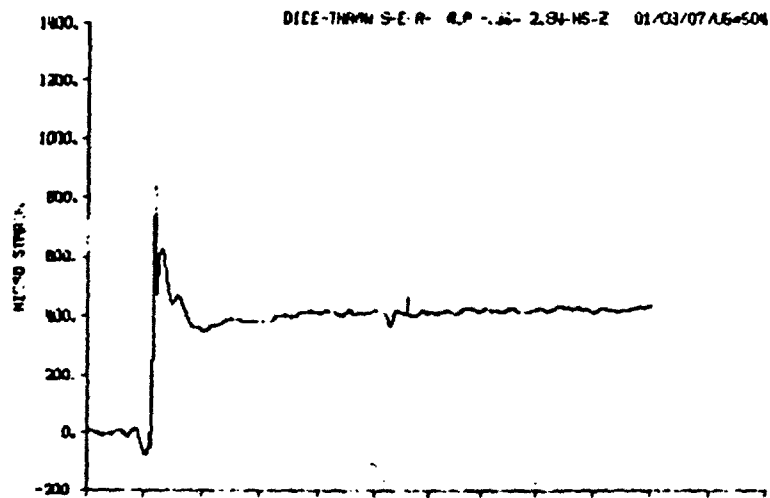
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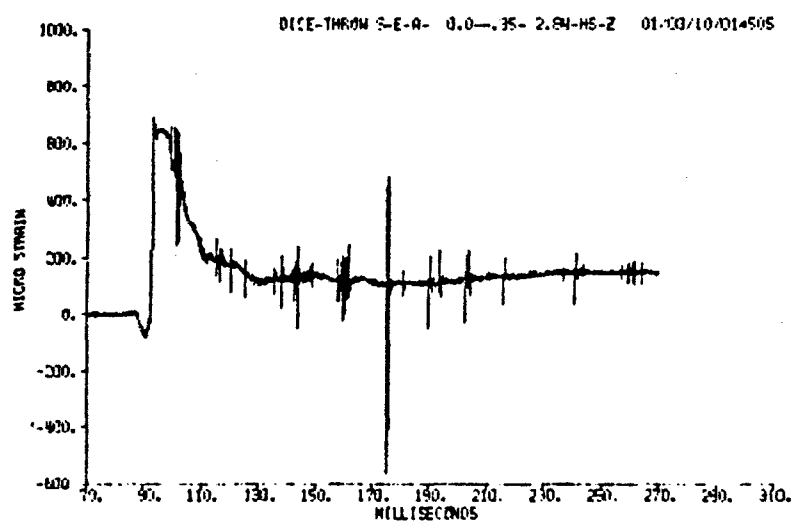
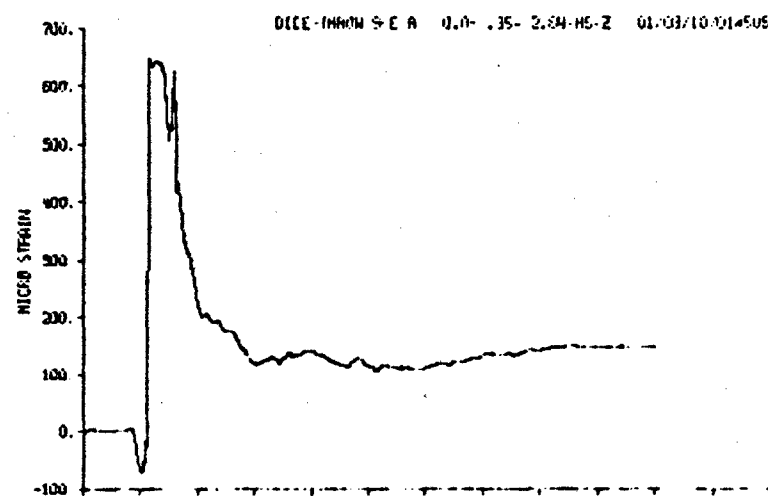
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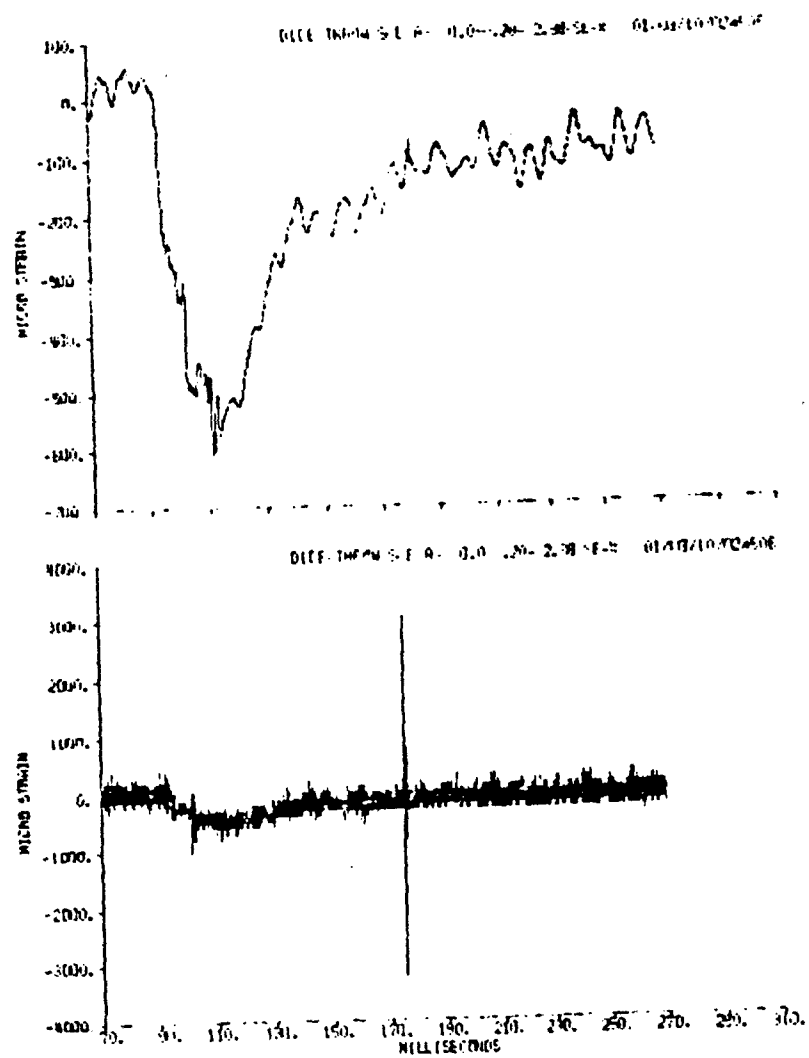


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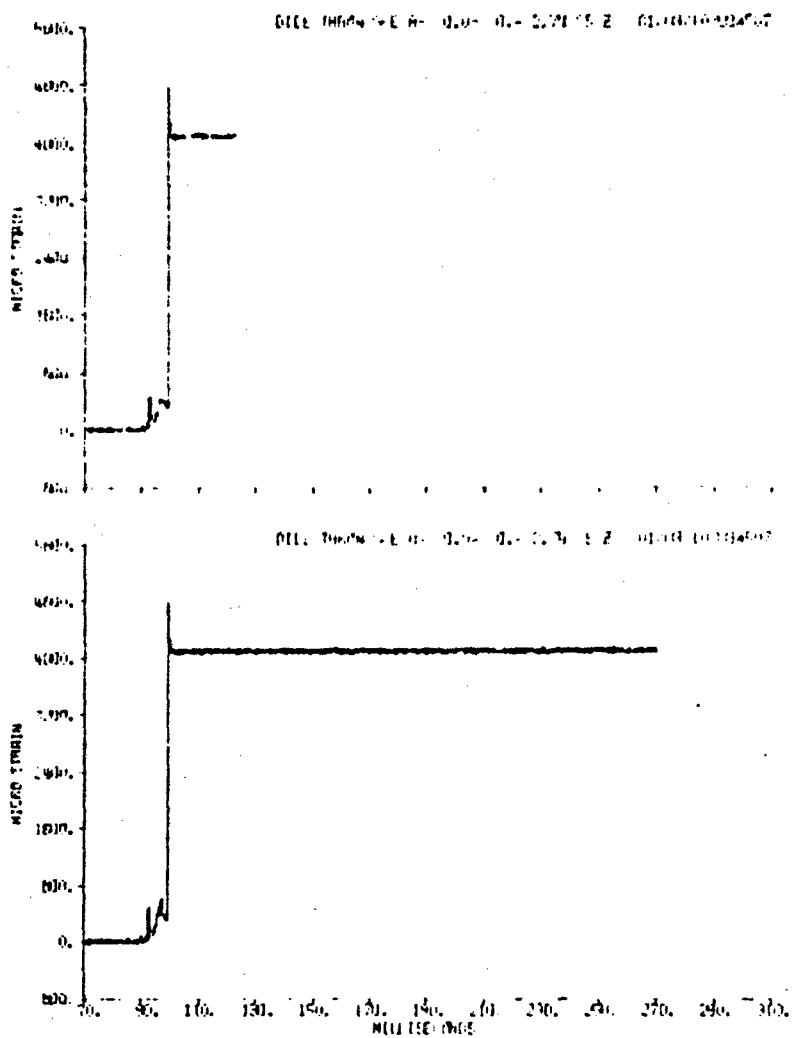


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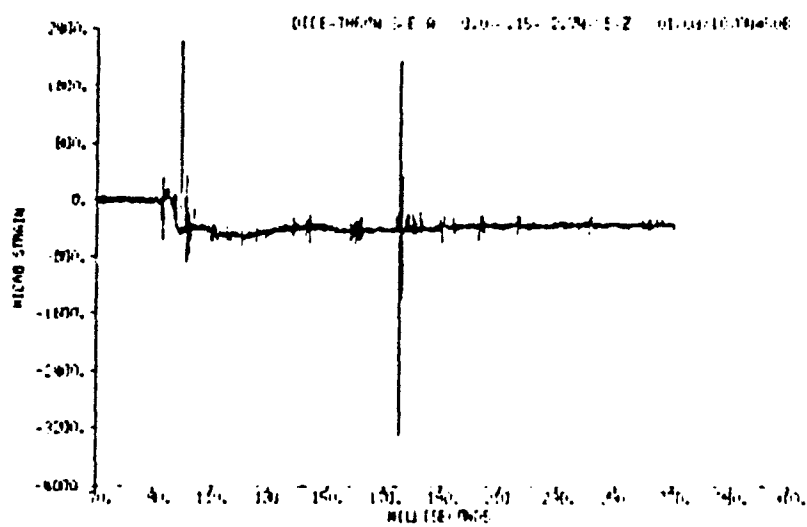
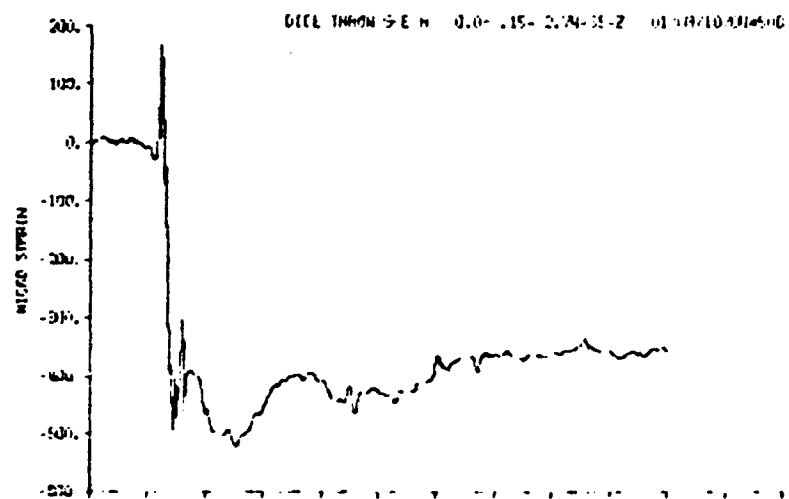


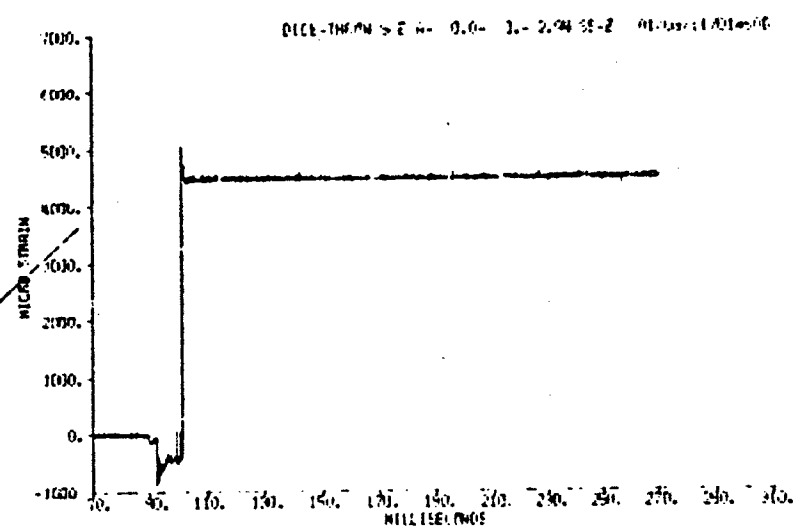
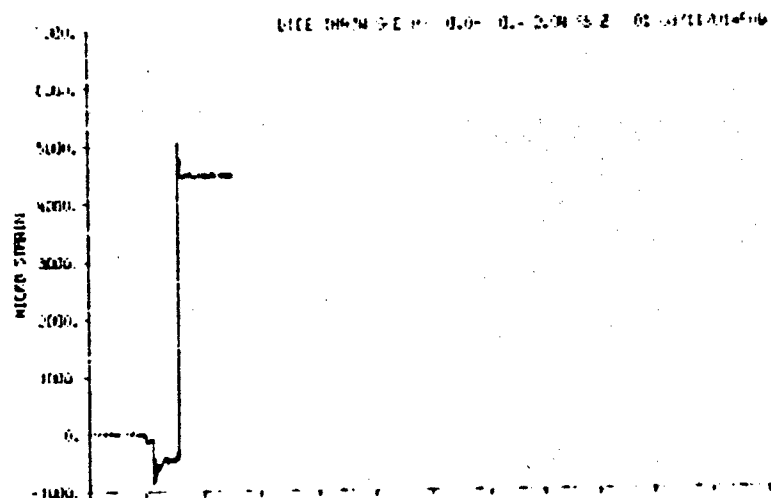


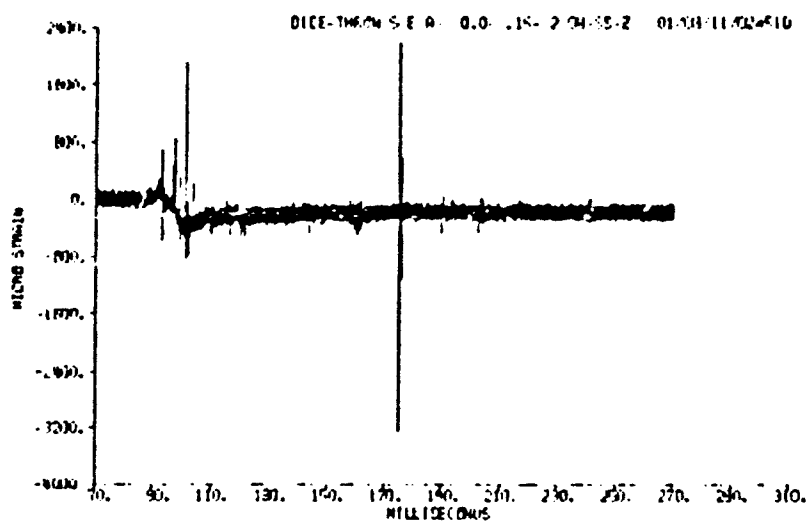
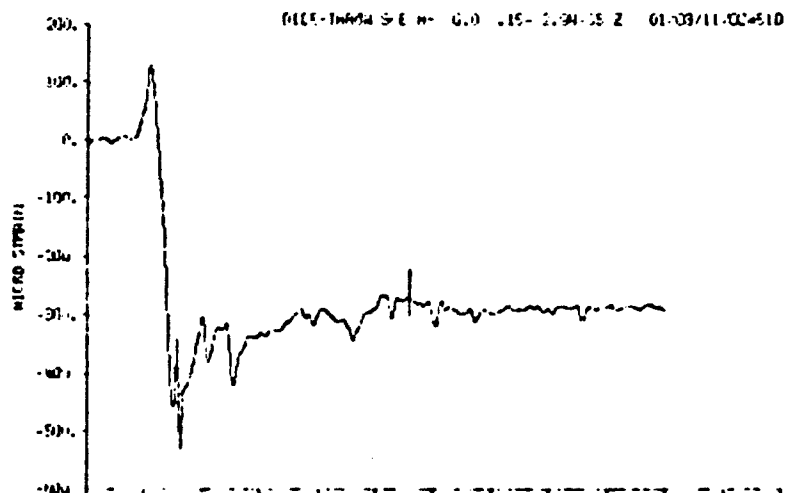




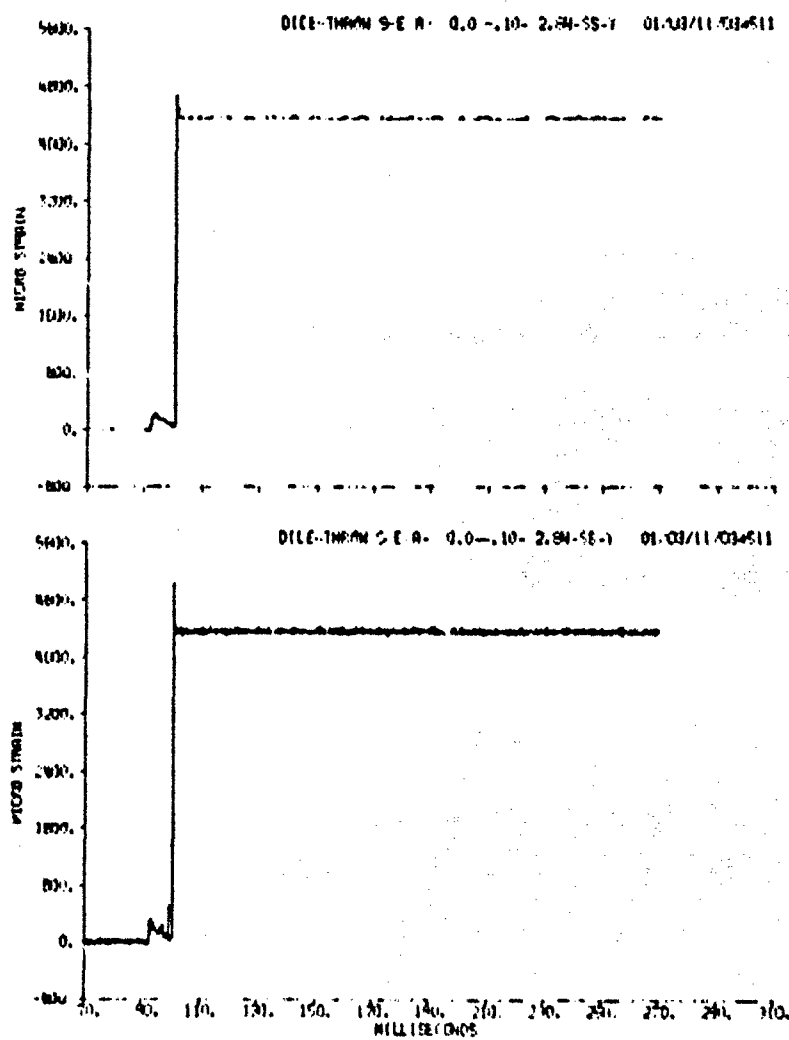
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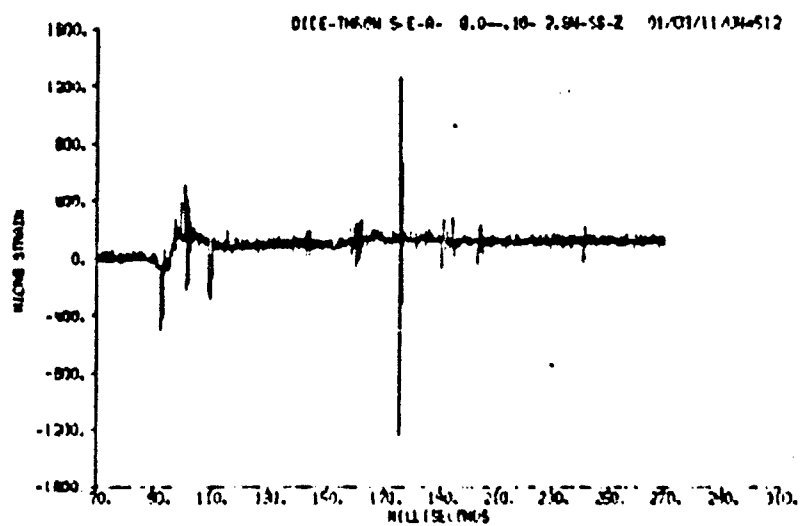
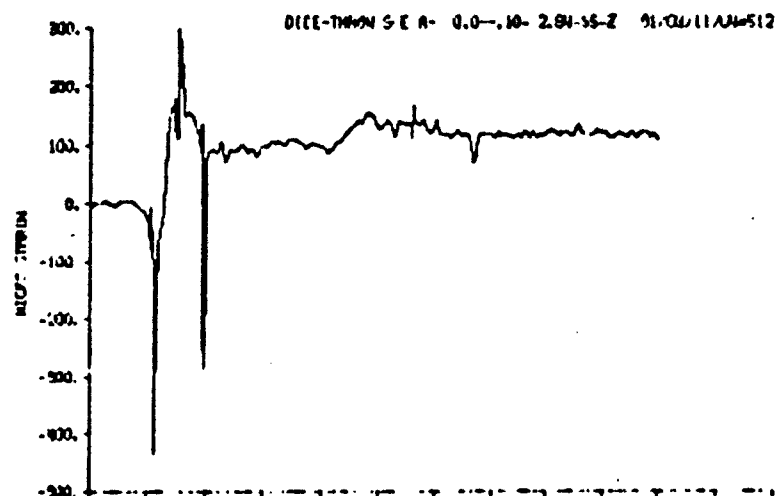




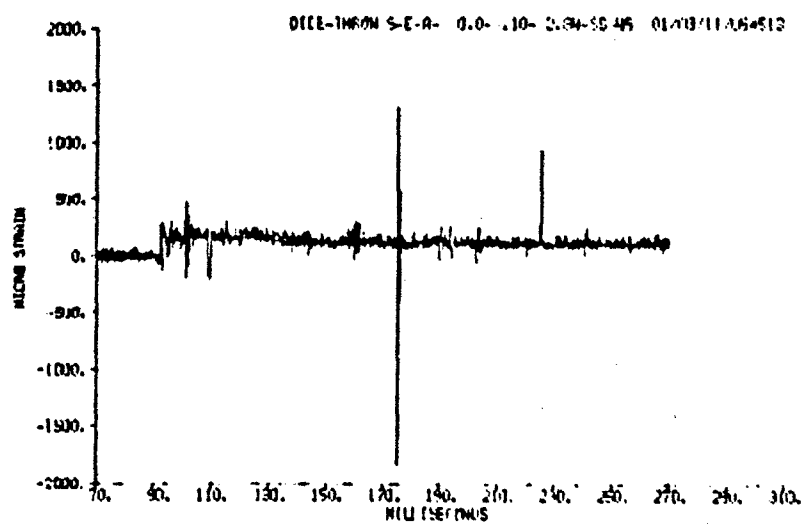
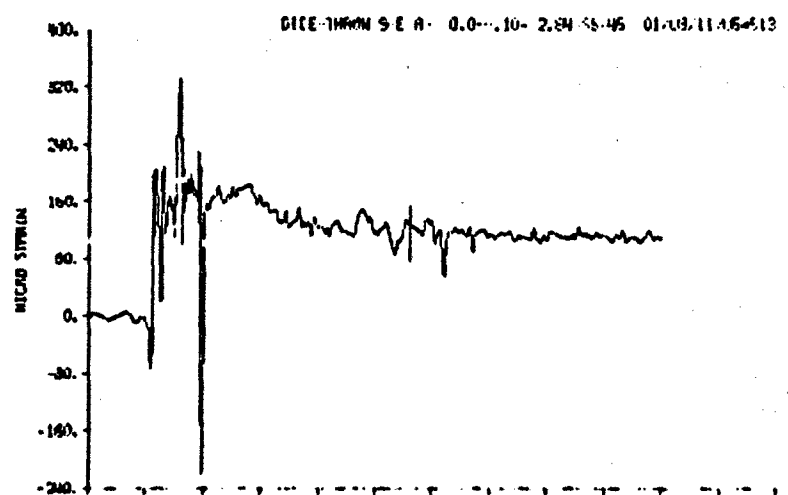
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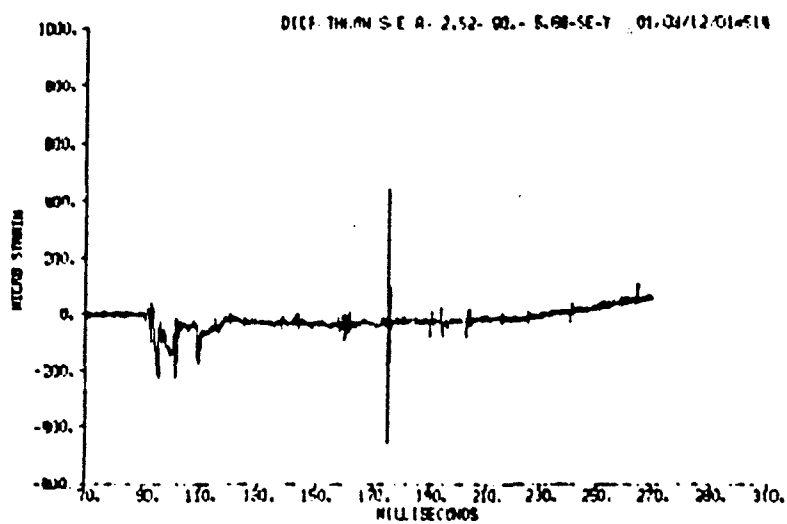
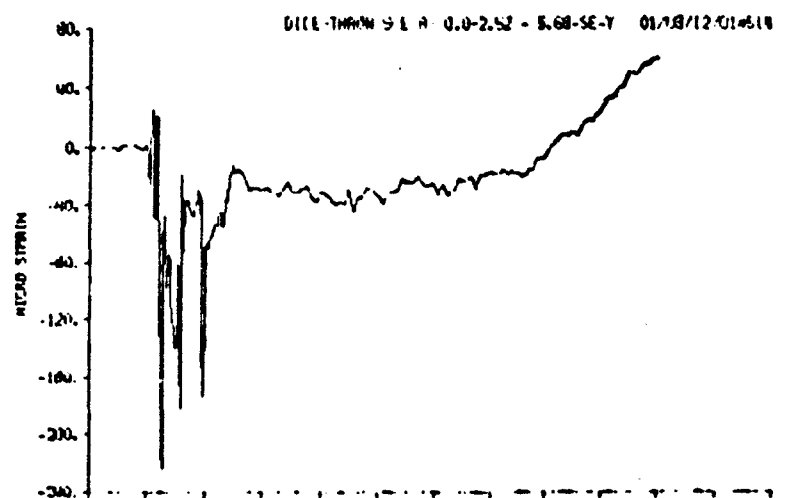
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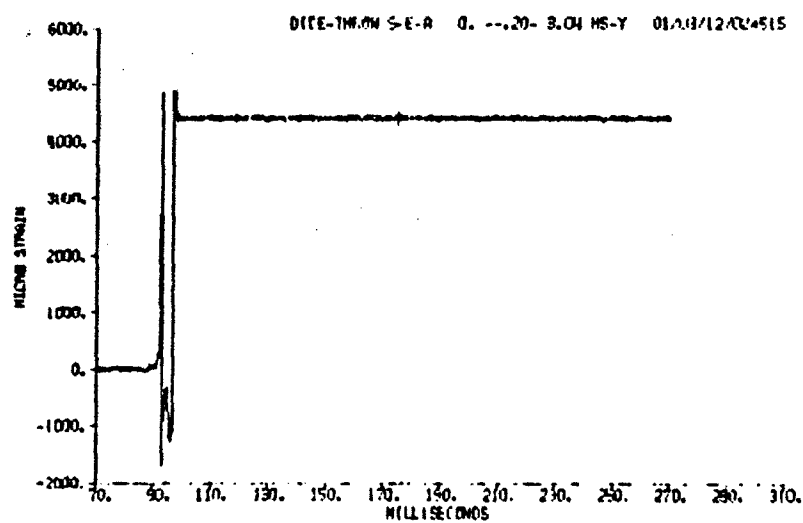
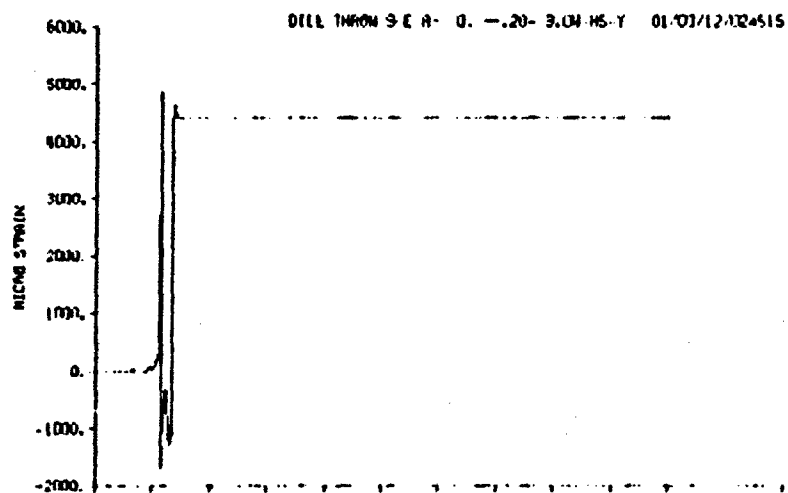


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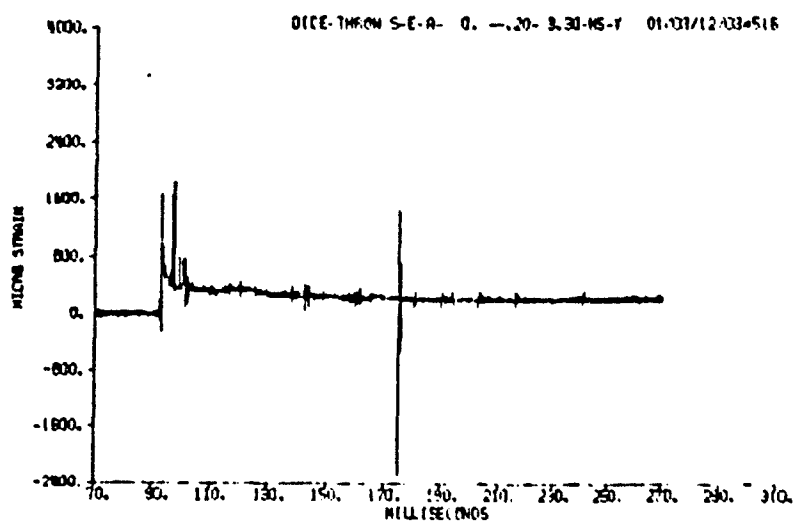
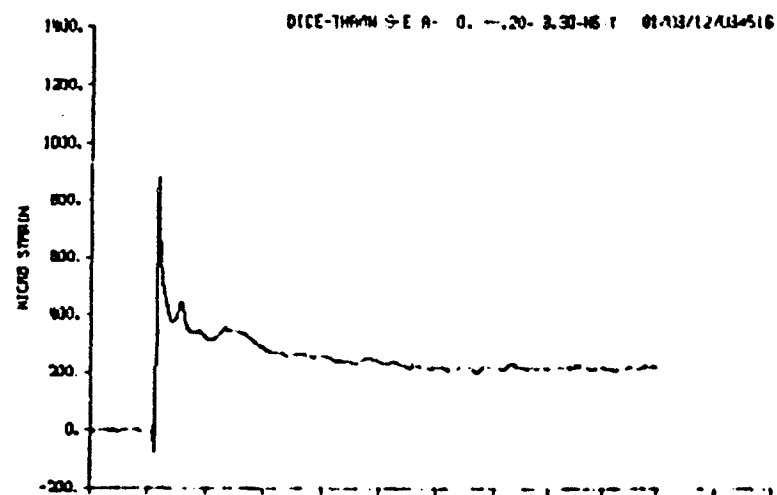




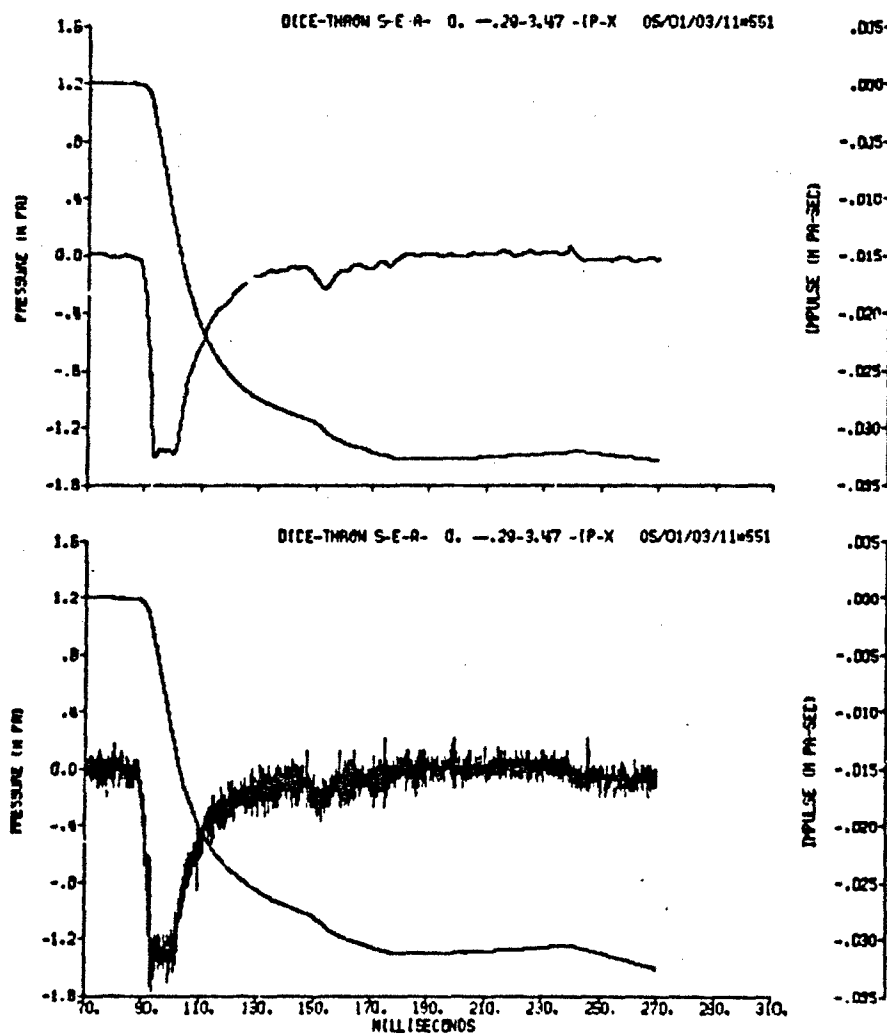
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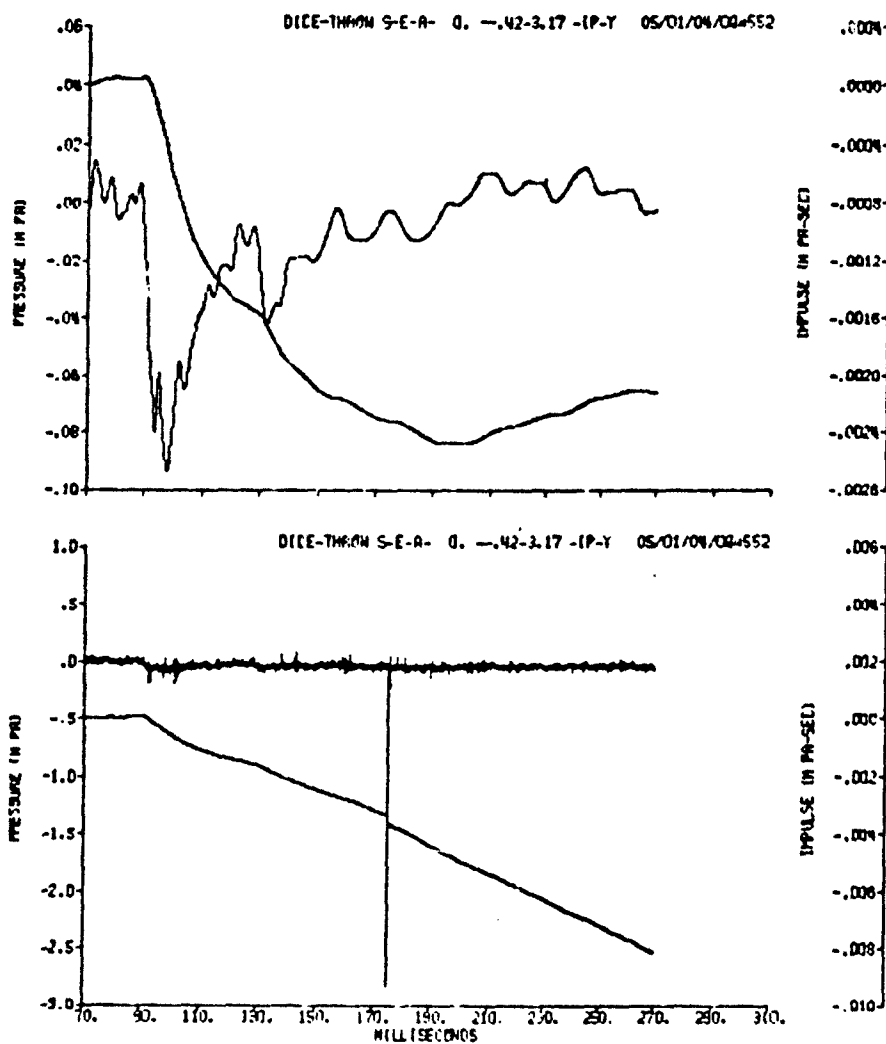
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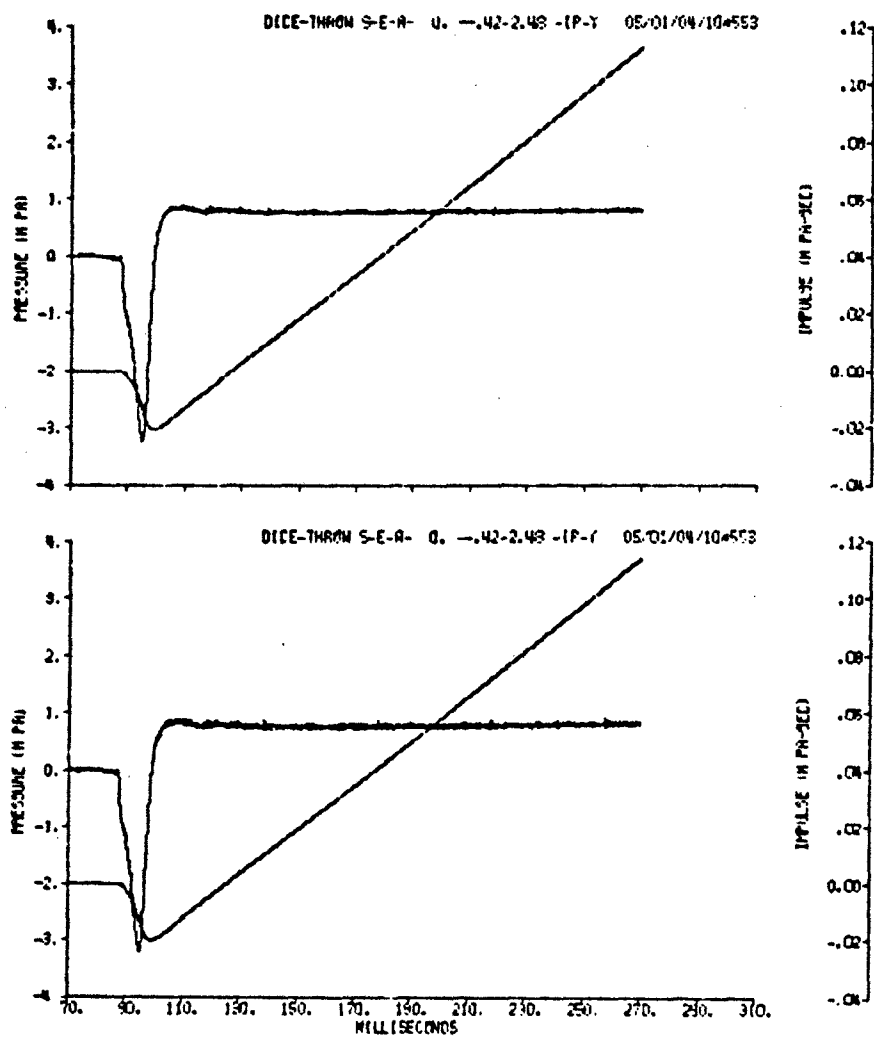
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AFWL-TR-77-001

APPENDIX E  
AIRCRAFT SHELTER "B" DATA PRESENTATION

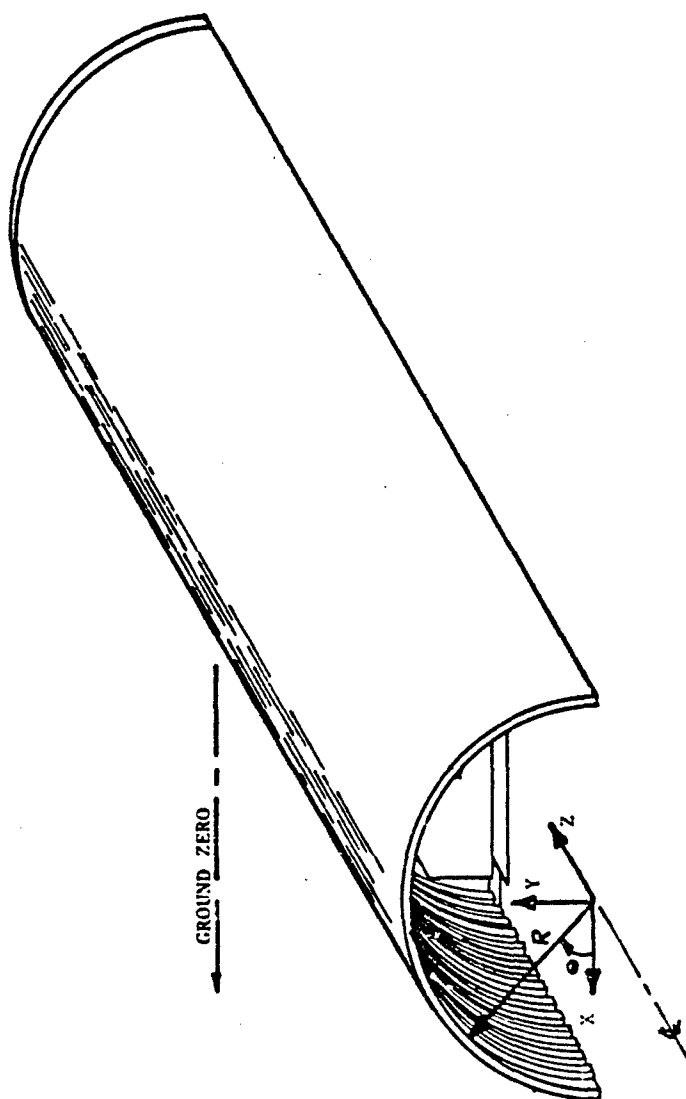


Figure E-1 Aircraft Shelter "s" Coordinate System

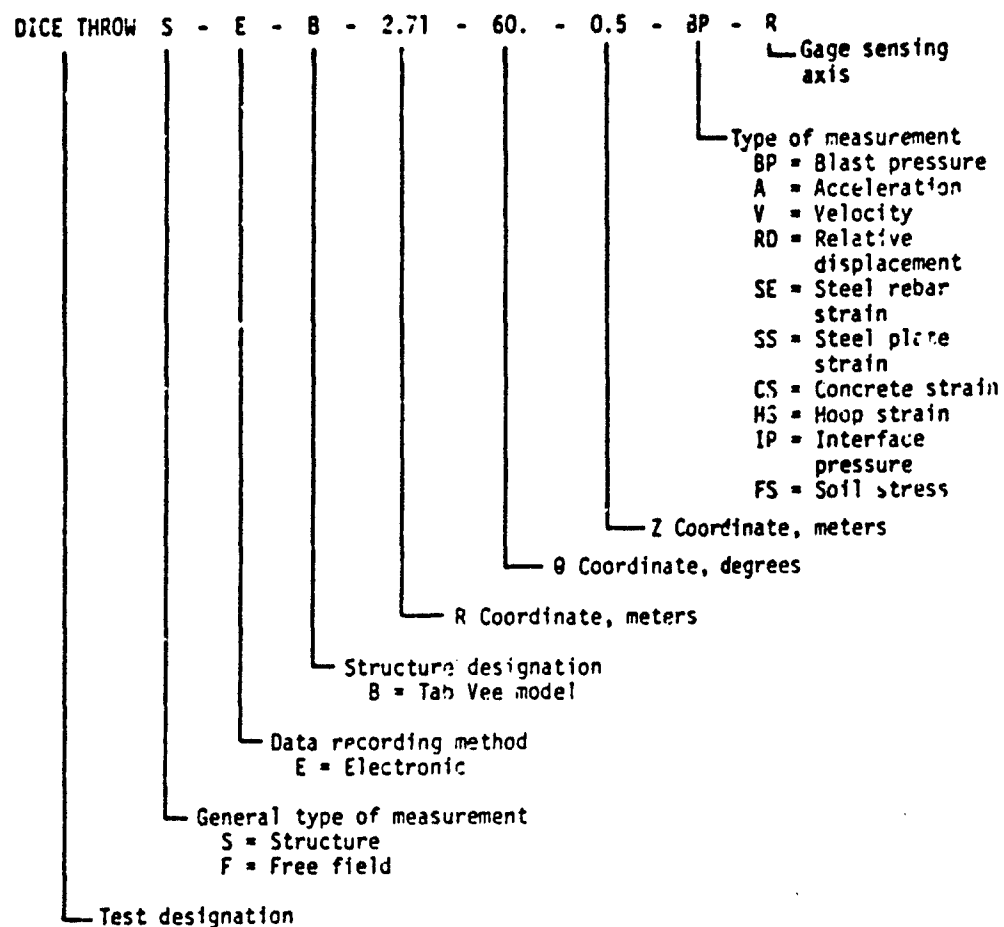


Figure E2. Measurement Designation System



DATA CORRECTIONS

DSP - points have been despiked.

SMT - a modified Hanning smooth has been performed.

FIL - a frequency cut-off or a band reject digital filter has been made.

BLC - the data has been baseline corrected.

INV - the polarity has been reversed.

On each page, the corrected plot is at the top and the uncorrected plot is at the bottom. Each acceleration plot is followed by its integral.

## DICE THROW, SHELTER B DATA CORRECTIONS

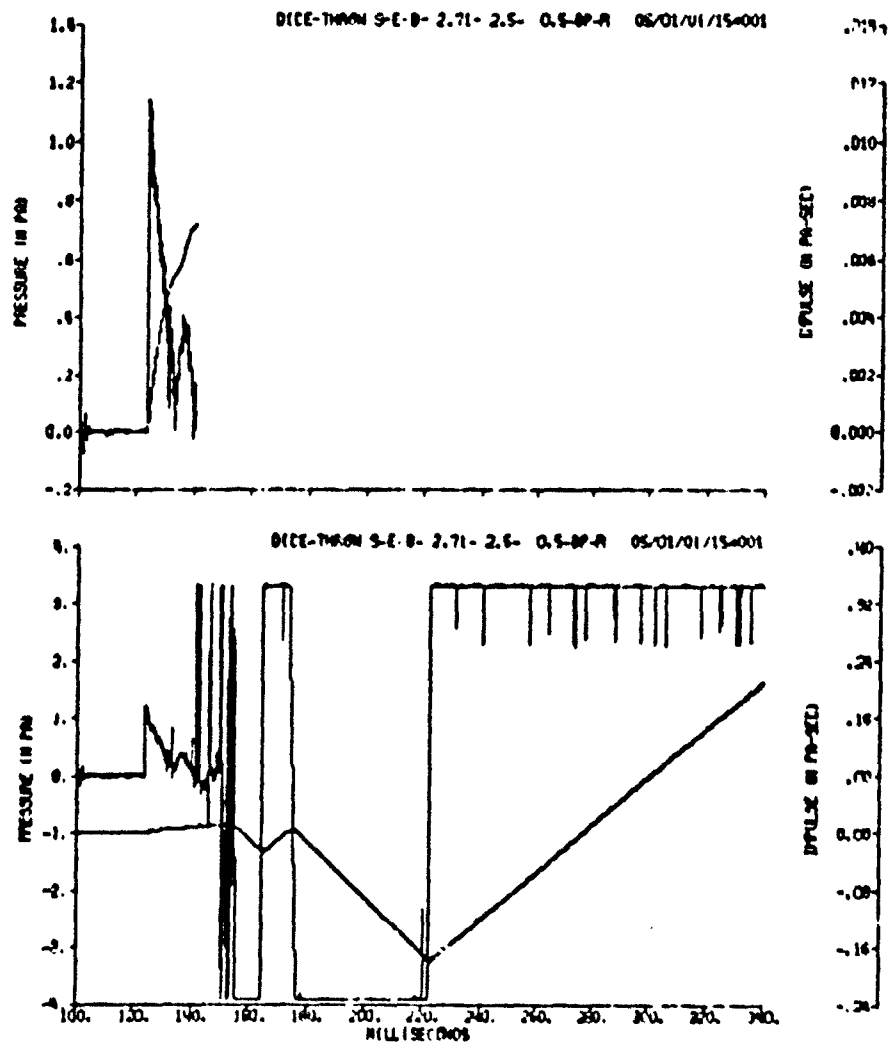
## COORDINATES

MEAS. NO.	R METERS	θ DEGREES	Z METERS	MEAS. TYPE	SENS. AXIS	DATA CORRECTIONS	GENERAL LOCATIONS
001	2.71	2.5	0.50	BP	R	DSP, SMT	Outer Surf of Struc
002	2.71	30	0.50	BP	R	DSP, SMT	Outer Surf of Struc
003	2.71	60	0.50	BP	R	DSP, SMT, BLC	Outer Surf of Struc
004	2.71	90	0.50	BP	R	DSP, SMT	Outer Surf of Struc
005	2.71	120	0.50	BP	R	DSP, SMT	Outer Surf of Struc
006	2.71	150	0.50	BP	R	DSP, SMT, BLC	Outer Surf of Struc
007	2.71	177.5	0.50	BP	R	DSP, SMT	Outer Surf of Struc
008	2.71	2.5	0.88	BP	R	DSP, SMT	Outer Surf/Middle of Struc
009	2.71	30	0.88	BP	R	DSP, SMT	Outer Surf/Middle of Struc
010	2.71	60	0.88	BP	R	DSP, SMT	Outer Surf/Middle of Struc
011	2.71	90	0.88	BP	R	DSP, SMT	Outer Surf/Middle of Struc
012	2.71	120	0.88	BP	R	DSP, SMT	Outer Surf/Middle of Struc
013	2.71	150	0.88	BP	R	DSP, SMT	Outer Surf/Middle of Struc
014	2.71	177.5	0.88	BP	R	DSP, SMT, BLC	Outer Surf/Middle of Struc
105	2.44	45	6.58	A	X	DSP, SMT	Inner Surf/Middle of Struc
106	2.44	45	6.58	A	Y	DSP, SMT, FIL	Inner Surf/Middle of Struc
107	2.44	90	6.58	A	X	DSP, SMT, BLC	Inner Surf/Middle of Struc
108	2.44	90	6.58	A	Y	DSP, SMT, BLC	Inner Surf/Middle of Struc
201	2.44	45	3.5	V	X	DSP, SMT, BLC	Inner Surf of Struc
202	2.44	45	3.5	V	Y	DSP, SMT, BLC	Inner Surf of Struc
203	2.44	90	3.5	V	X	DSP, SMT, BLC	Inner Surf of Struc
204	2.44	90	3.5	V	Y	DSP, SMT, BLC	Inner Surf of Struc
205	2.44	135	3.5	V	X	DSP, SMT, BLC	Inner Surf of Struc
206	2.44	135	3.5	V	Y	SMT	Inner Surf of Struc
207	2.44	45	6.58	V	X	DSP, SMT, BLC	Inner Surf/Middle of Struc
208	2.44	45	6.58	V	Y	DSP, SMT	Inner Surf/Middle of Struc
209	2.44	90	6.58	V	X	DSP, SMT	Inner Surf/Middle of Struc
210	2.44	90	6.58	V	Y	DSP, SMT, BLC	Inner Surf/Middle of Struc

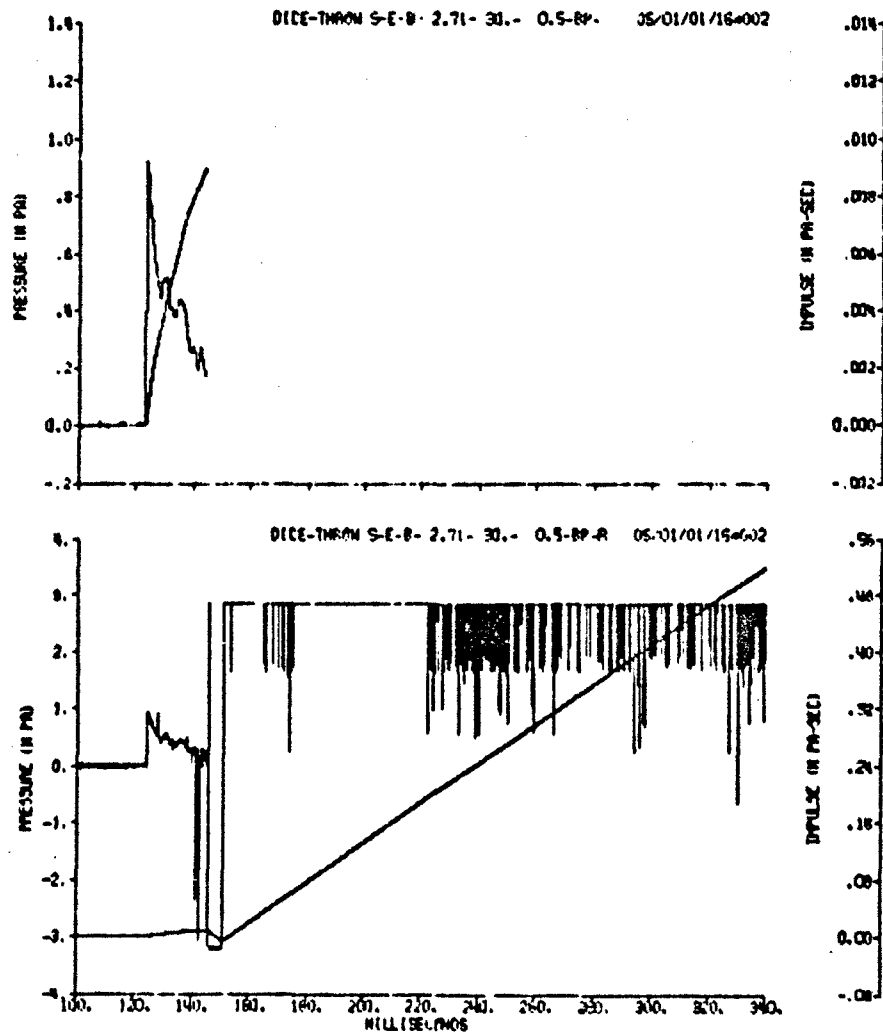
## DICE THROW, SHELTER B DATA CORRECTIONS (cont'd)

COORDINATES							GENERAL LOCATIONS
MEAS. NO.	R METERS	θ DEGREES	Z METERS	MEAS. TYPE	SENS. AXIS	DATA CORRECTIONS	
211	2.44	135	6.58	V	X	DSP, SMT, BLC	Inner Surf/Middle of Struc
212	2.44	135	6.58	V	Y	DSP, SMT, BLC	Inner Surf/Middle of Struc
232	2.44	2.5	6.58	V	X	DSP, SMT, BLC	Inner Surf/Middle of Struc
233	2.44	2.5	6.58	V	Y	DSP, SMT, BLC	Inner Surf/Middle of Struc
234	2.44	177.5	6.58	V	R	DSP, SMT, BLC	Inner Surf/Middle of Struc
235	2.44	177.5	6.58	V	Y	DSP, SMT	Inner Surf/Middle of Struc
401	2.68	30	3.5	SE	R	Scratched	Inner Reinf of Super Struc
402	2.68	60	3.5	SE	R	DSP, SMT, FIL	Inner Reinf of Super Struc
403	2.68	90	3.5	SE	R	DSP, SMT, FIL	Inner Reinf of Super Struc
404	2.68	120	3.5	SE	R	DSP, SMT	Inner Reinf of Super Struc
405	2.68	150	3.5	SE	R	Scratched	Inner Reinf of Super Struc
406	2.46	30	3.5	SE	R	Scratched	Outer Reinf of Super Struc
407	2.46	60	3.5	SE	R	DSP, SMT	Outer Reinf of Super Struc
408	2.46	90	3.5	SE	R	DSP, SMT	Outer Reinf of Super Struc
409	2.46	120	3.5	SE	R	DSP, SMT	Outer Reinf of Super Struc
410	2.46	150	3.5	SE	R	DSP, SMT	Outer Reinf of Super Struc
411	2.68	30	6.58	SE	R	DSP, SMT	Inner Surf/Middle of Struc
412	2.68	60	6.58	SE	R	DSP, SMT	Inner Surf/Middle of Struc
413	2.68	90	6.58	SE	R	DSP, SMT	Inner Surf/Middle of Struc
414	2.68	120	6.58	SE	R	DSP, SMT	Inner Surf/Middle of Struc
415	2.68	150	6.58	SE	R	DSP, SMT	Inner Surf/Middle of Struc
416	2.46	30	6.58	SE	R	DSP	Outer Surf/Middle of Struc
417	2.46	60	6.58	SE	R	DSP, SMT	Outer Surf/Middle of Struc
418	2.46	90	6.58	SE	R	DSP, SMT	Outer Surf/Middle of Struc
419	2.46	120	6.58	SE	R	DSP, SMT	Outer Surf/Middle of Struc
420	2.46	150	6.58	SE	R	DSP, SMT	Outer Surf/Middle of Struc

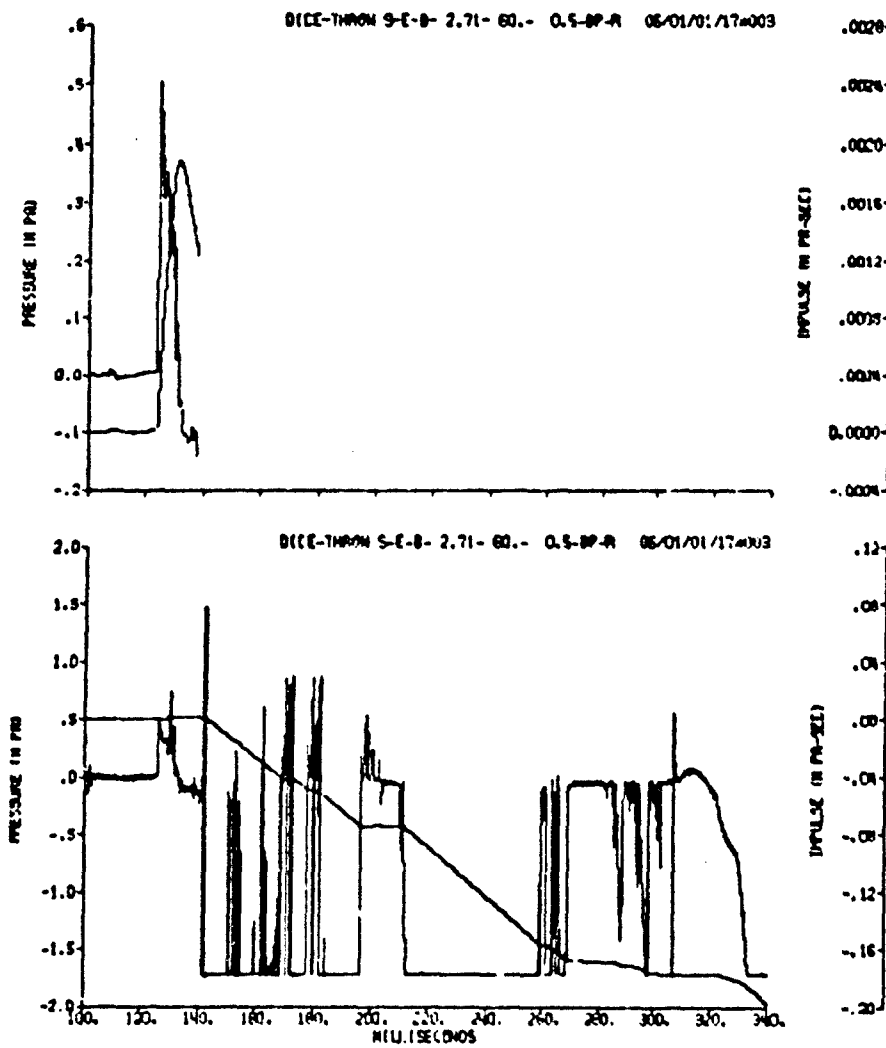
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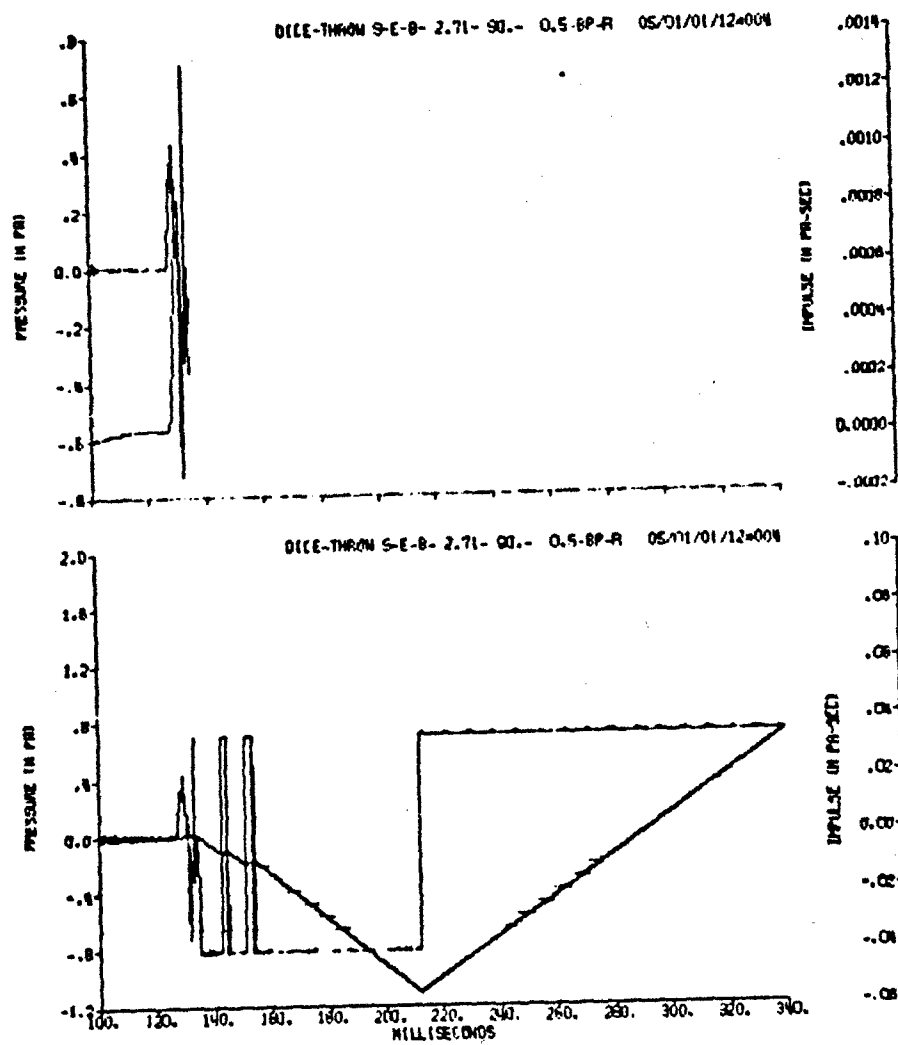
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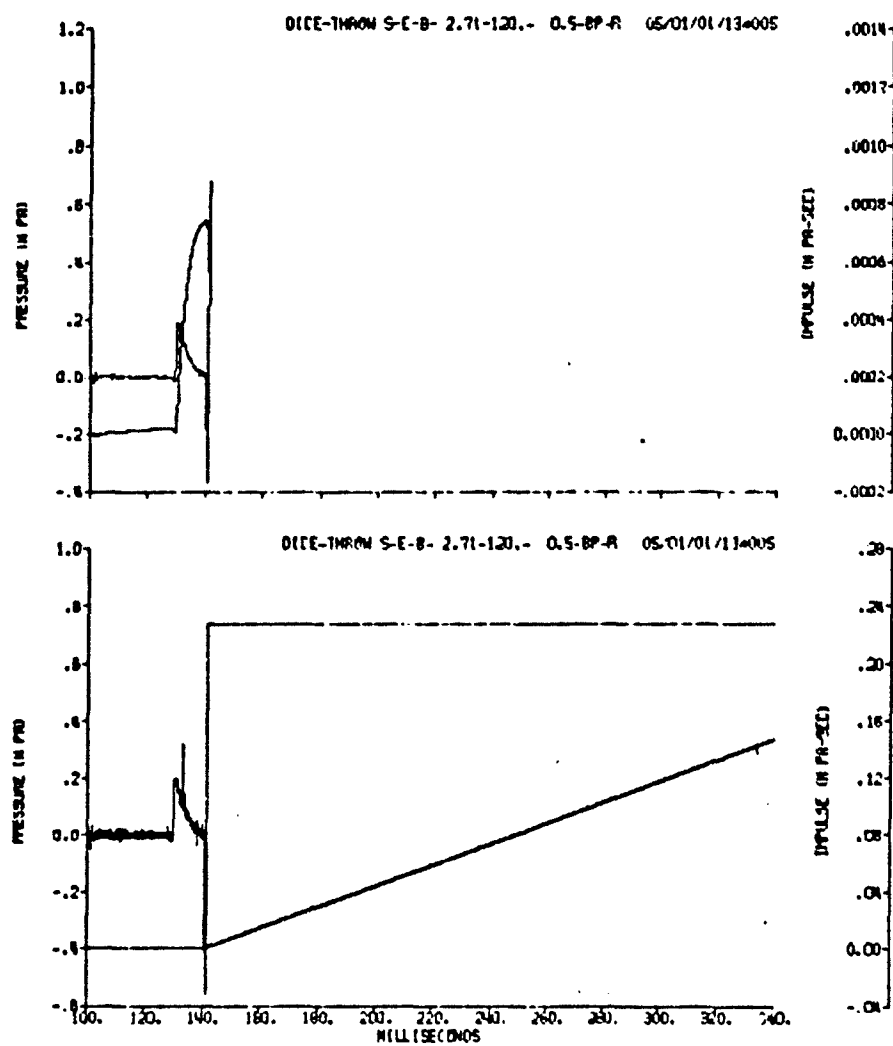
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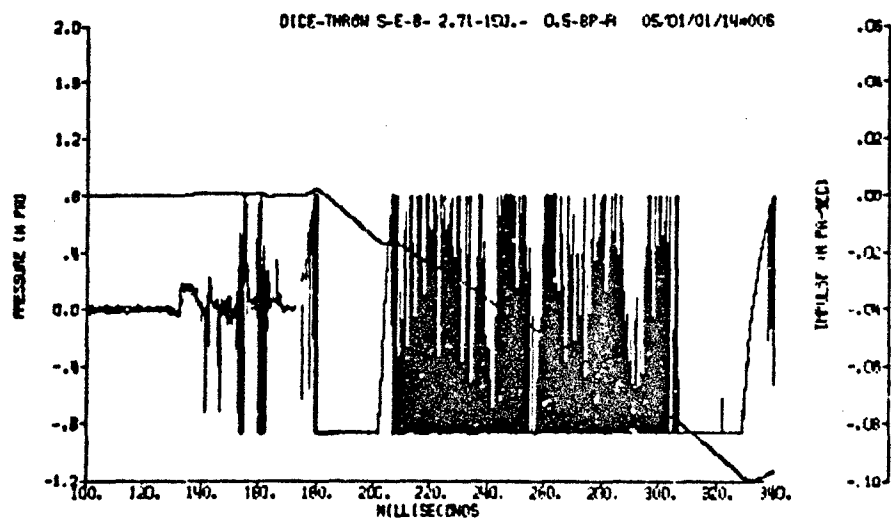
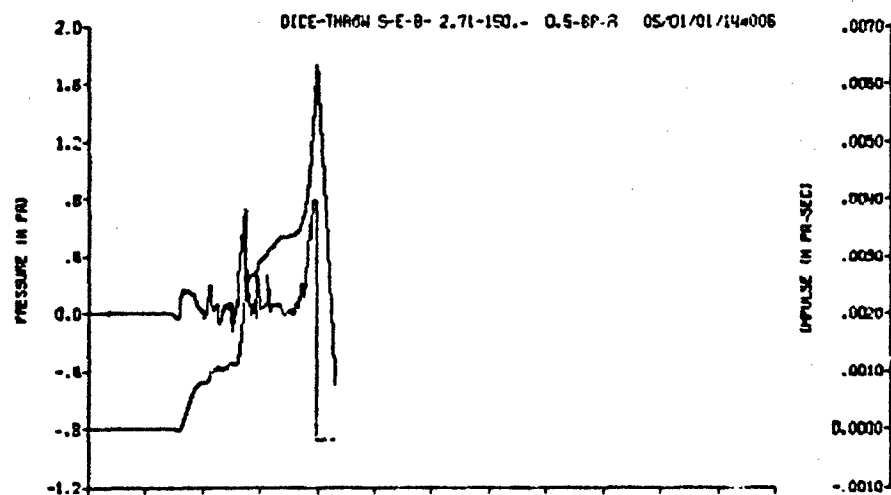


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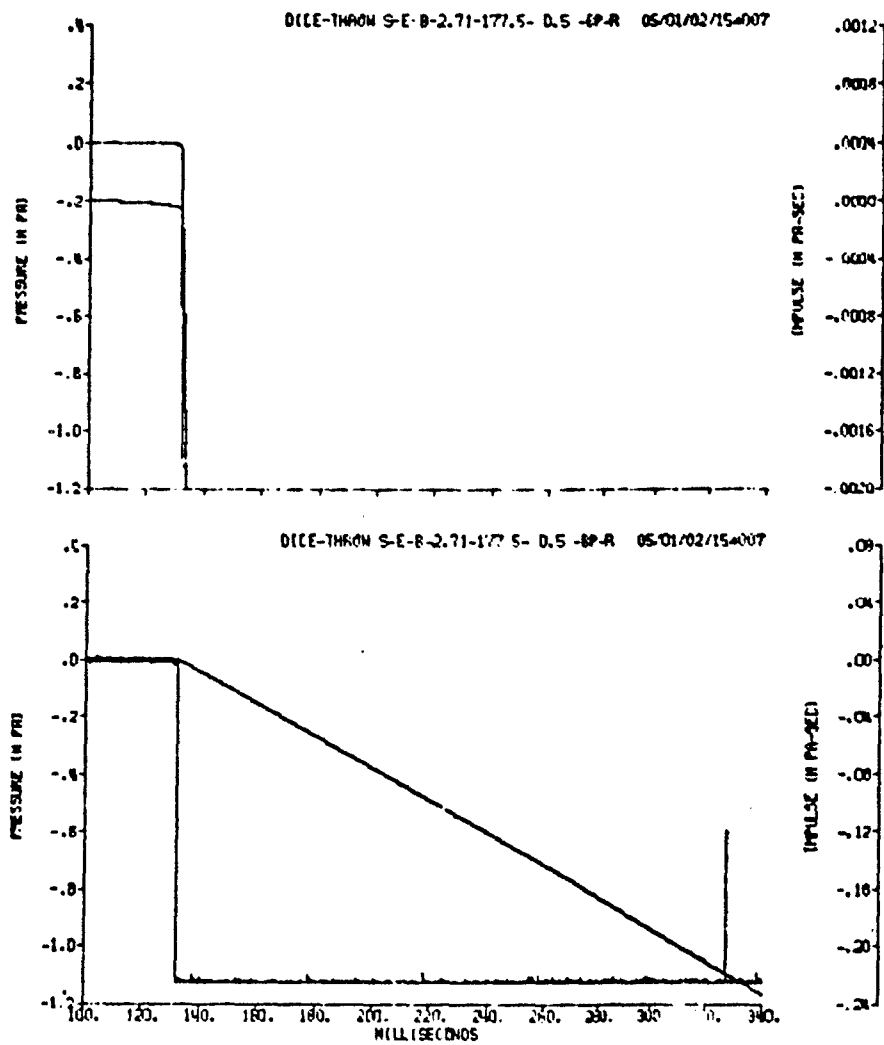




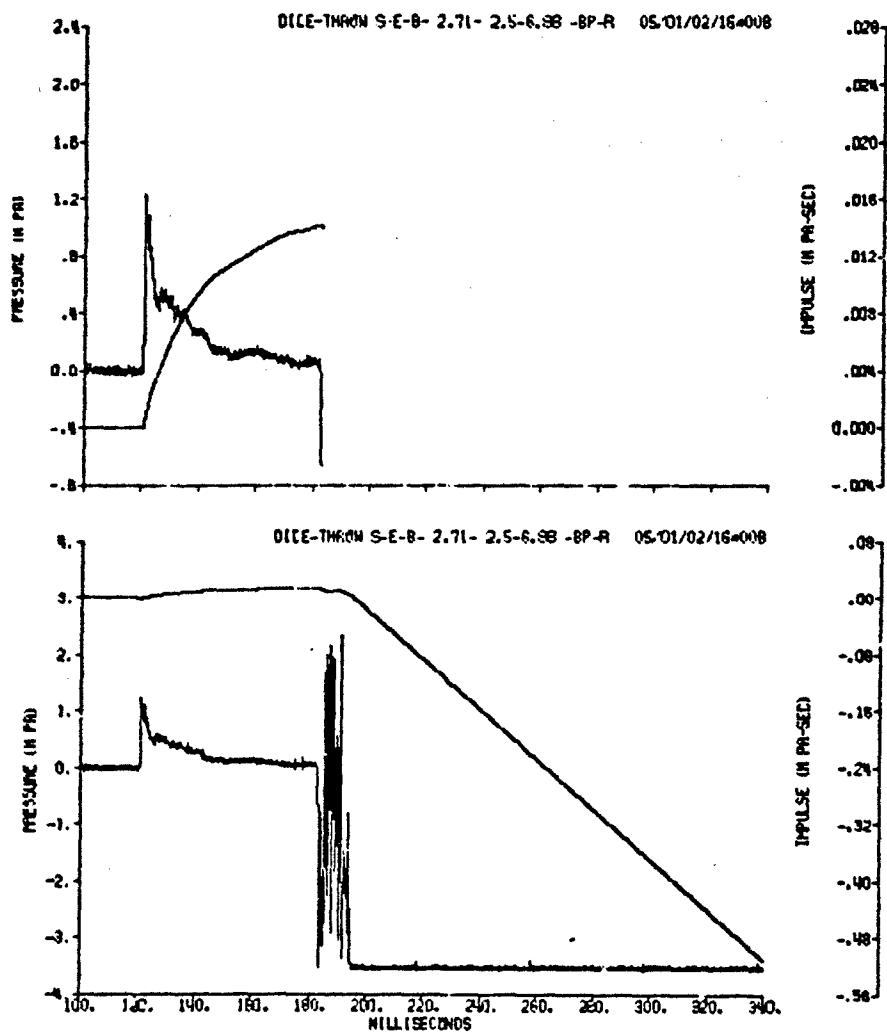
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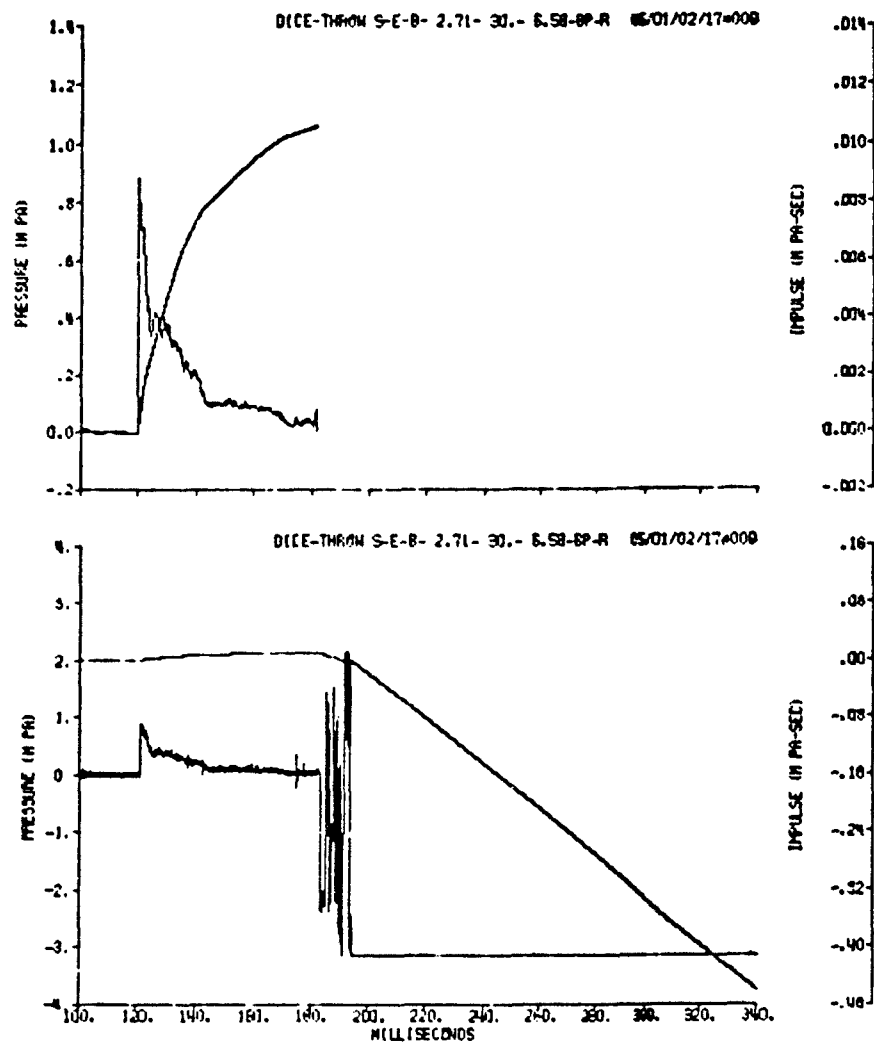
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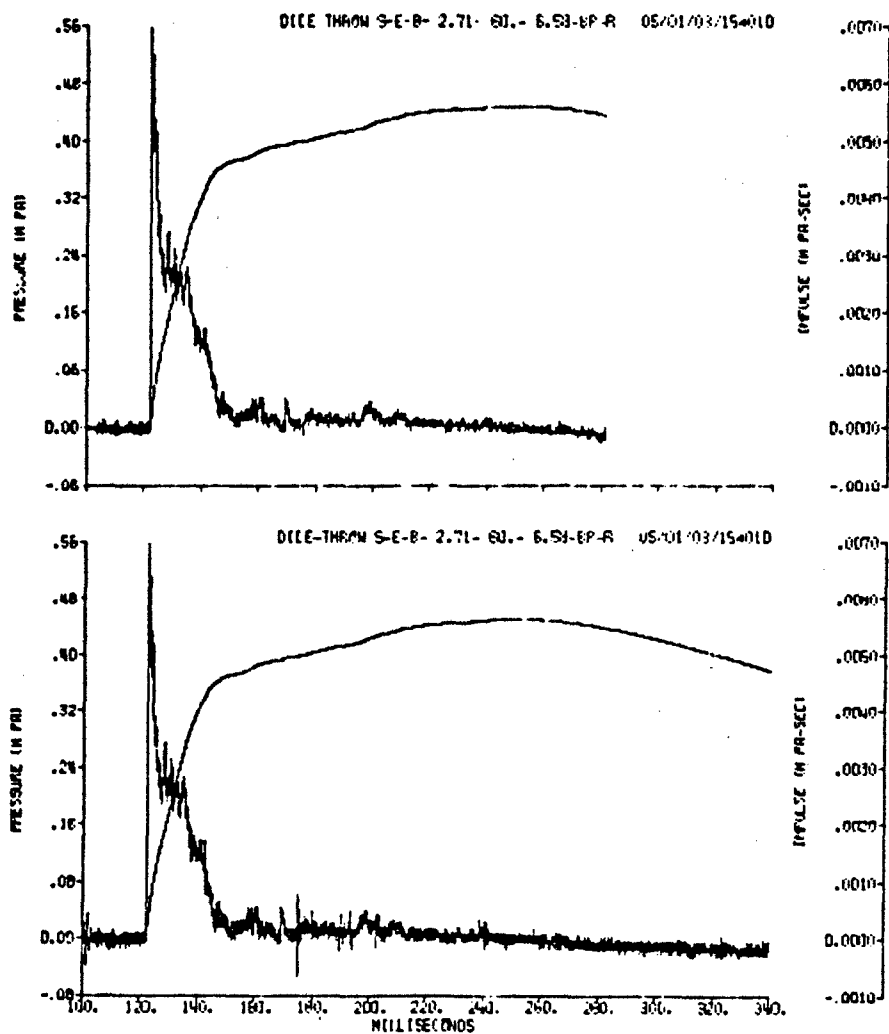
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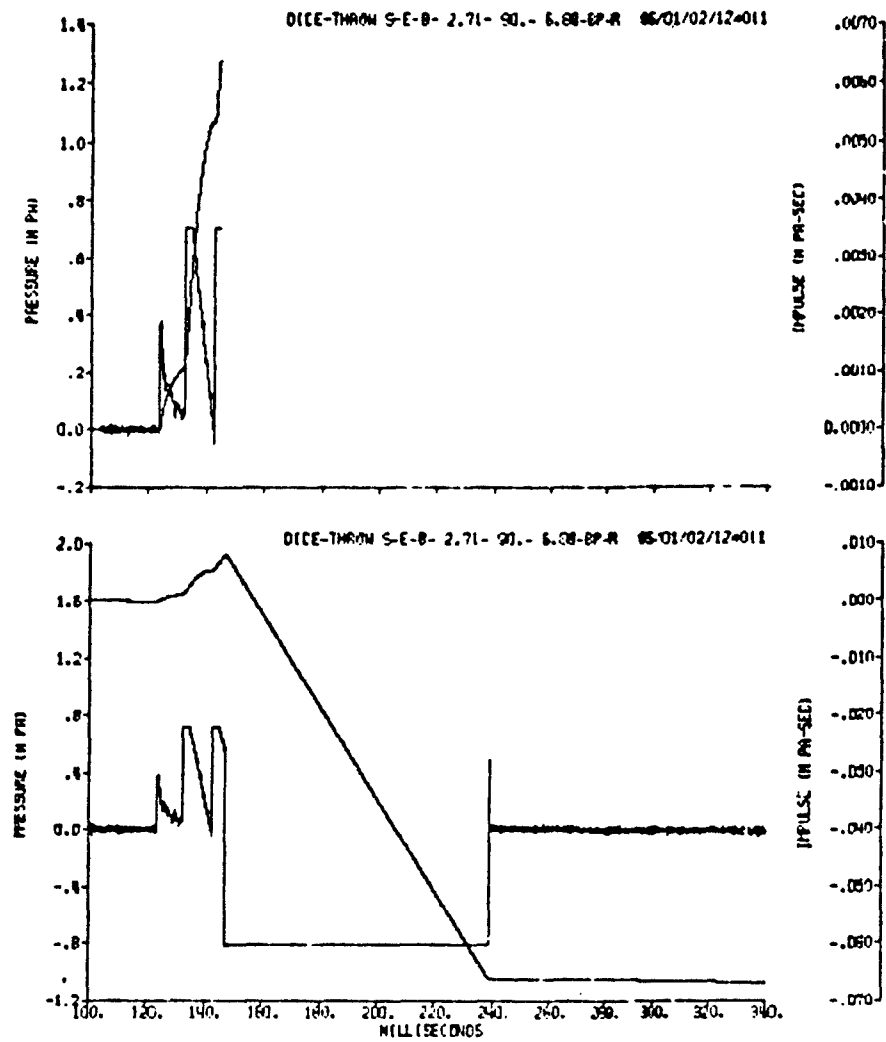
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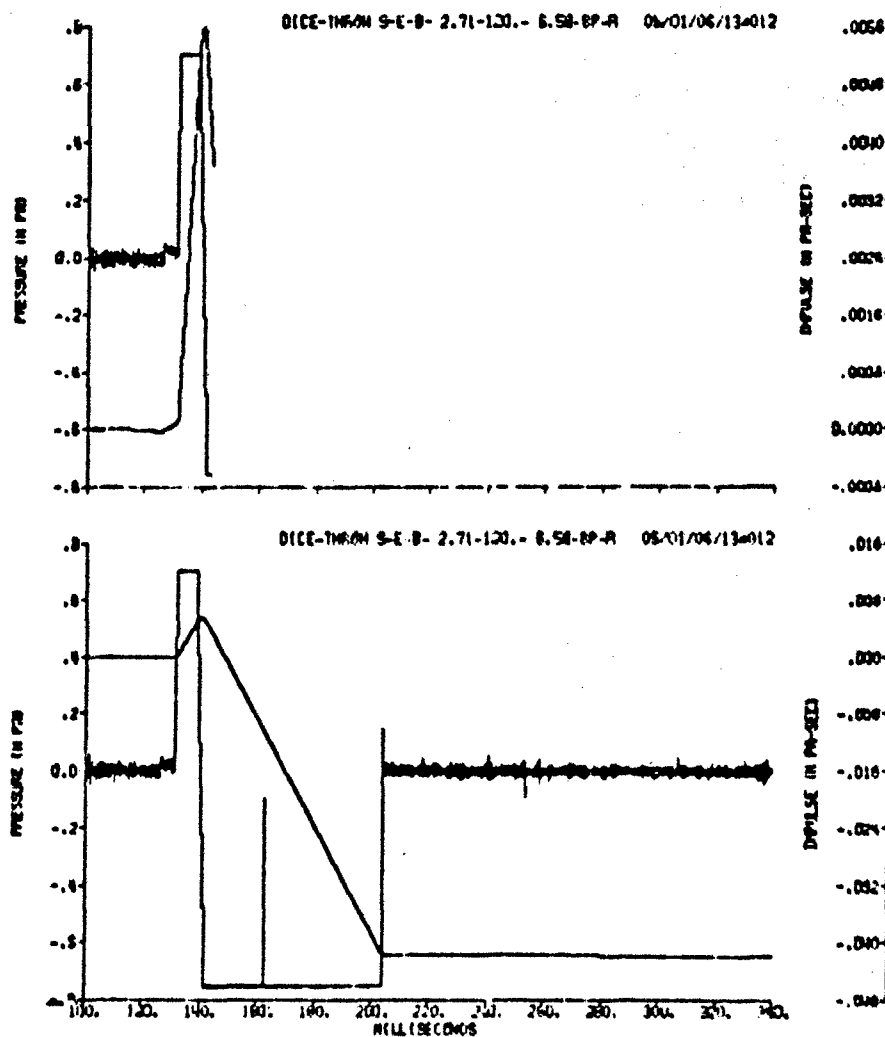
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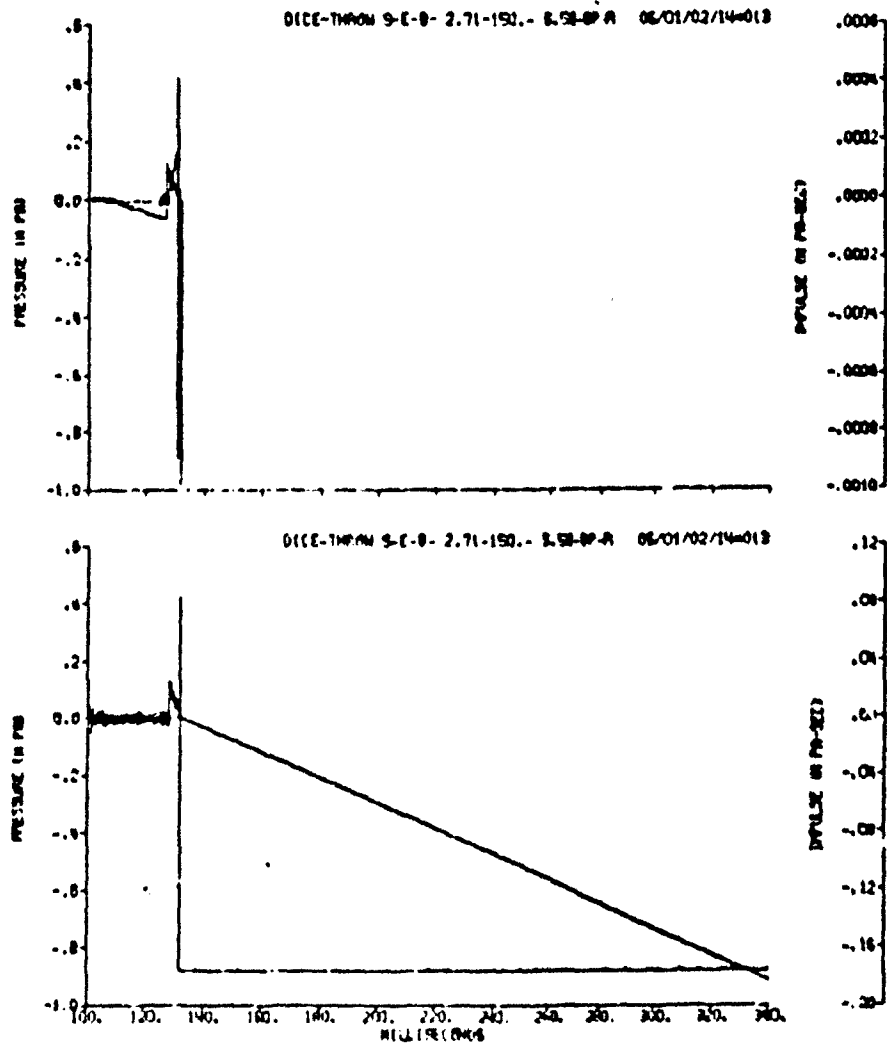
AFWL-TR-77-007



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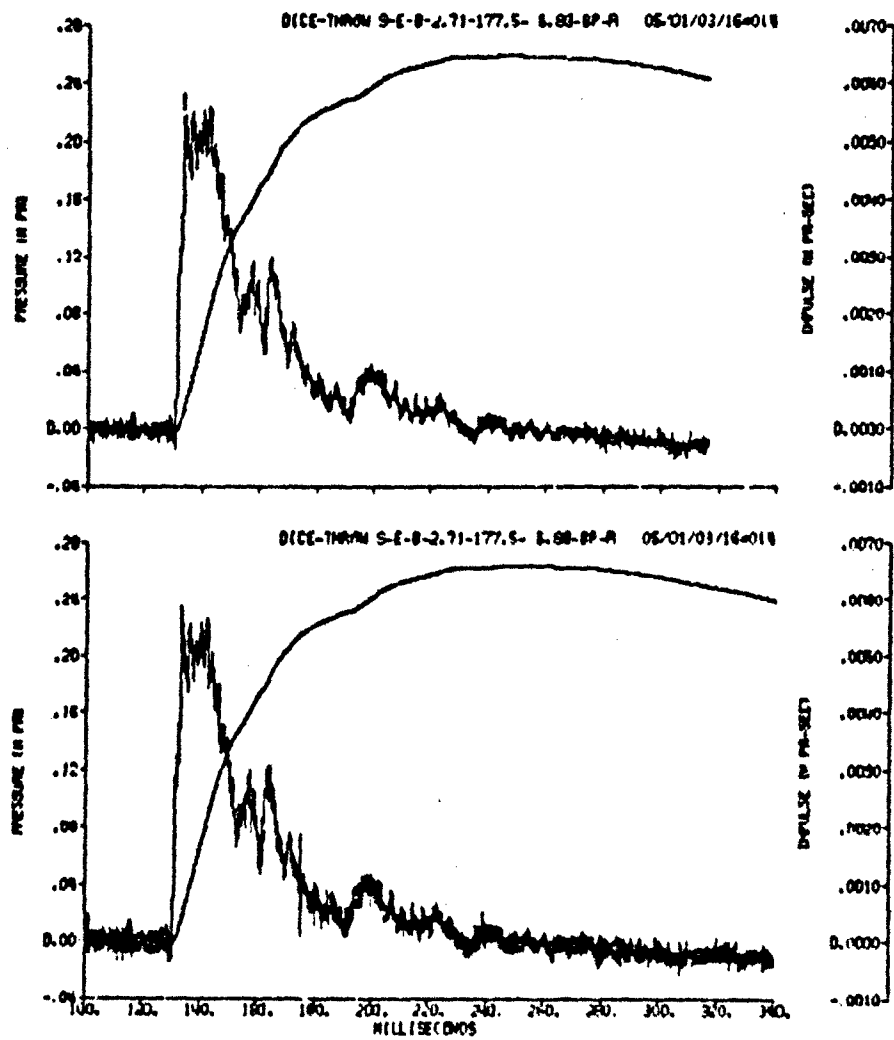


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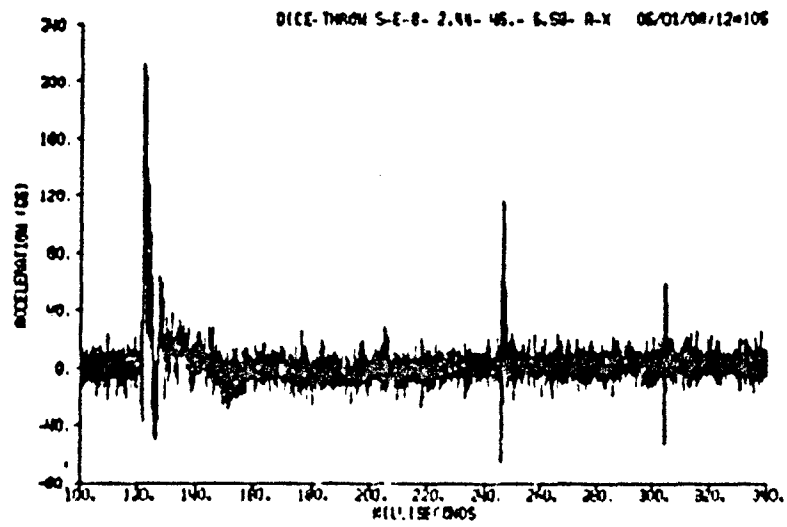
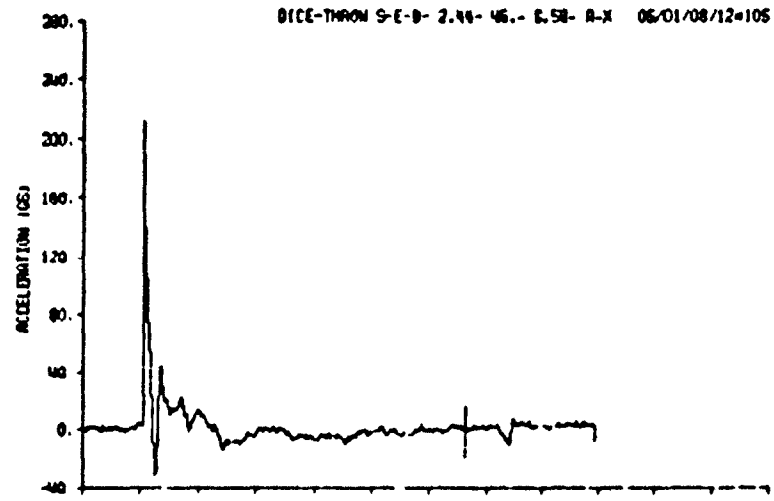


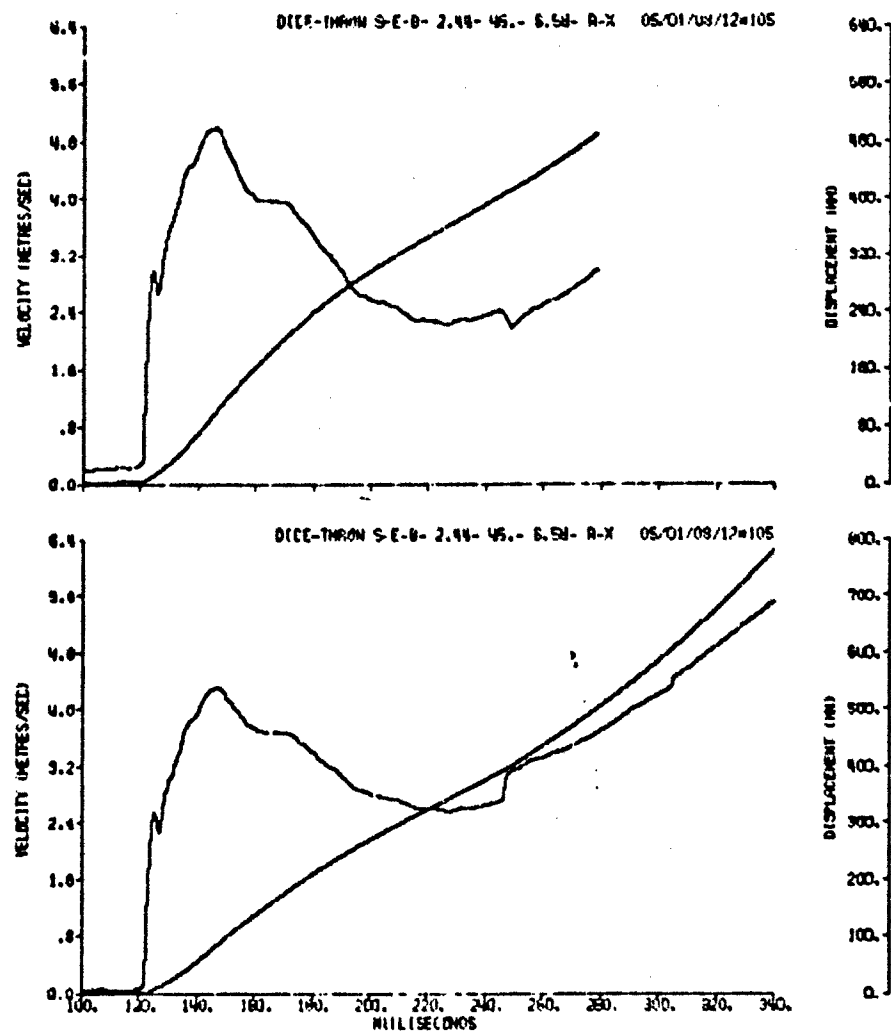


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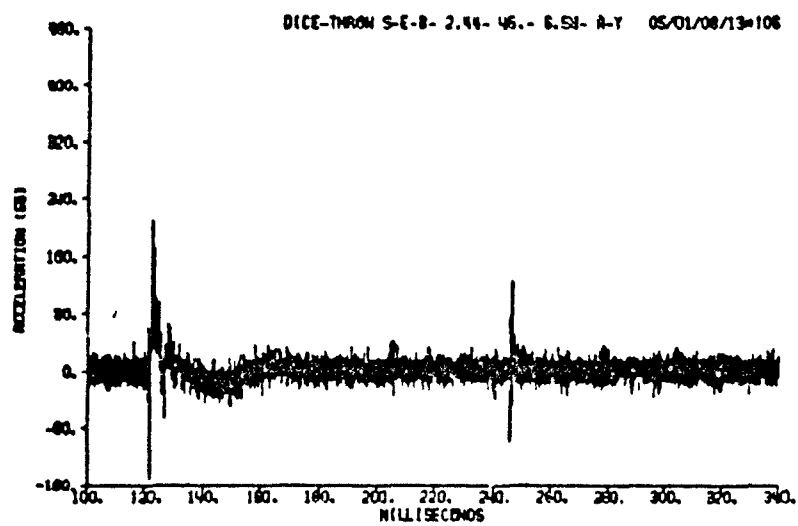
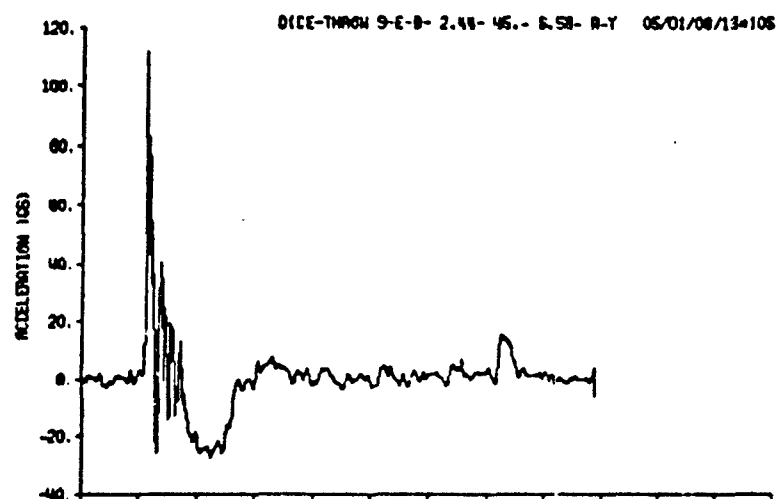


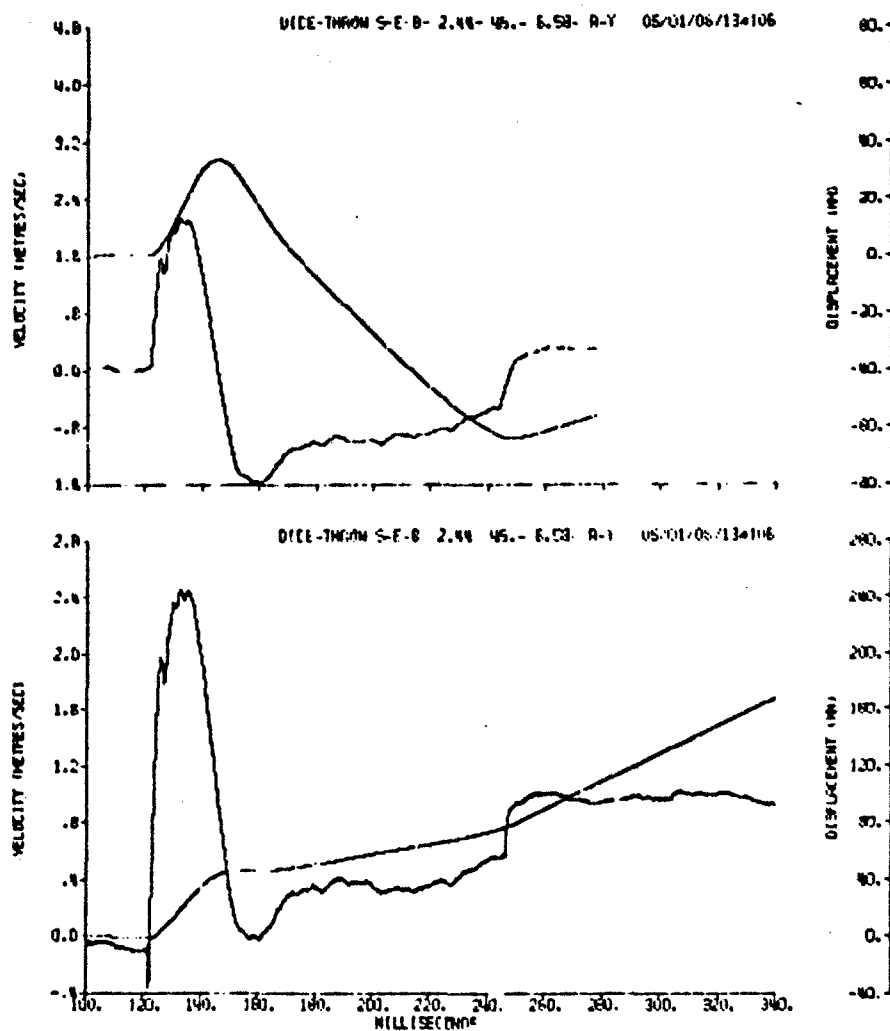
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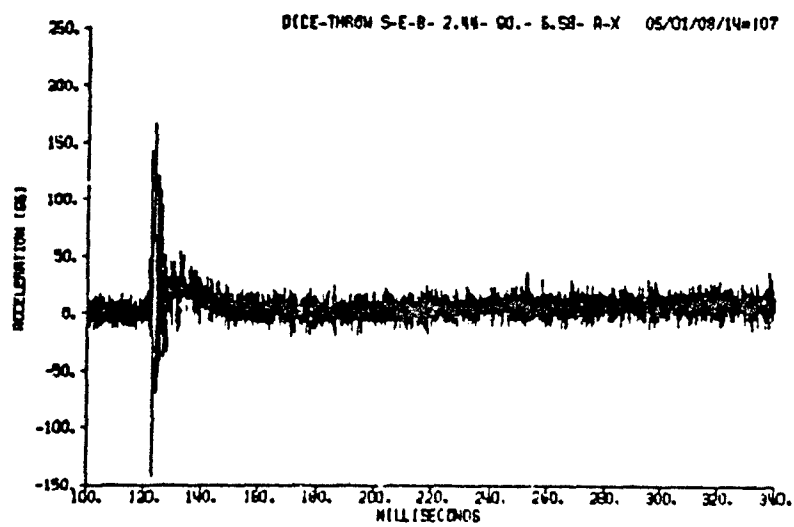
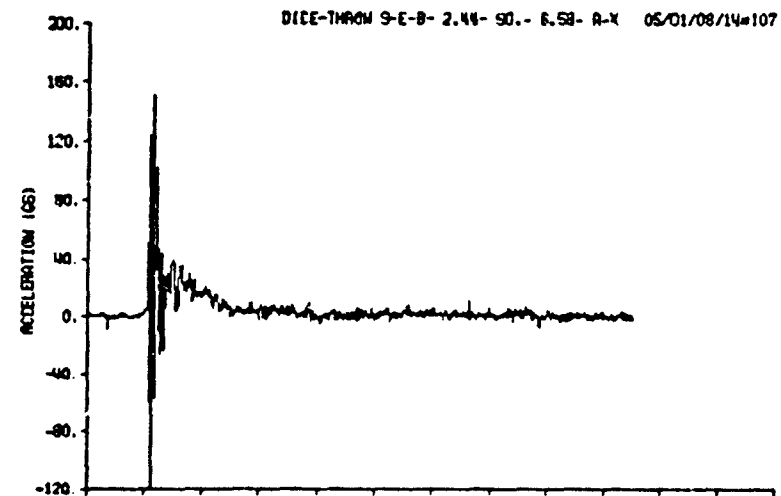


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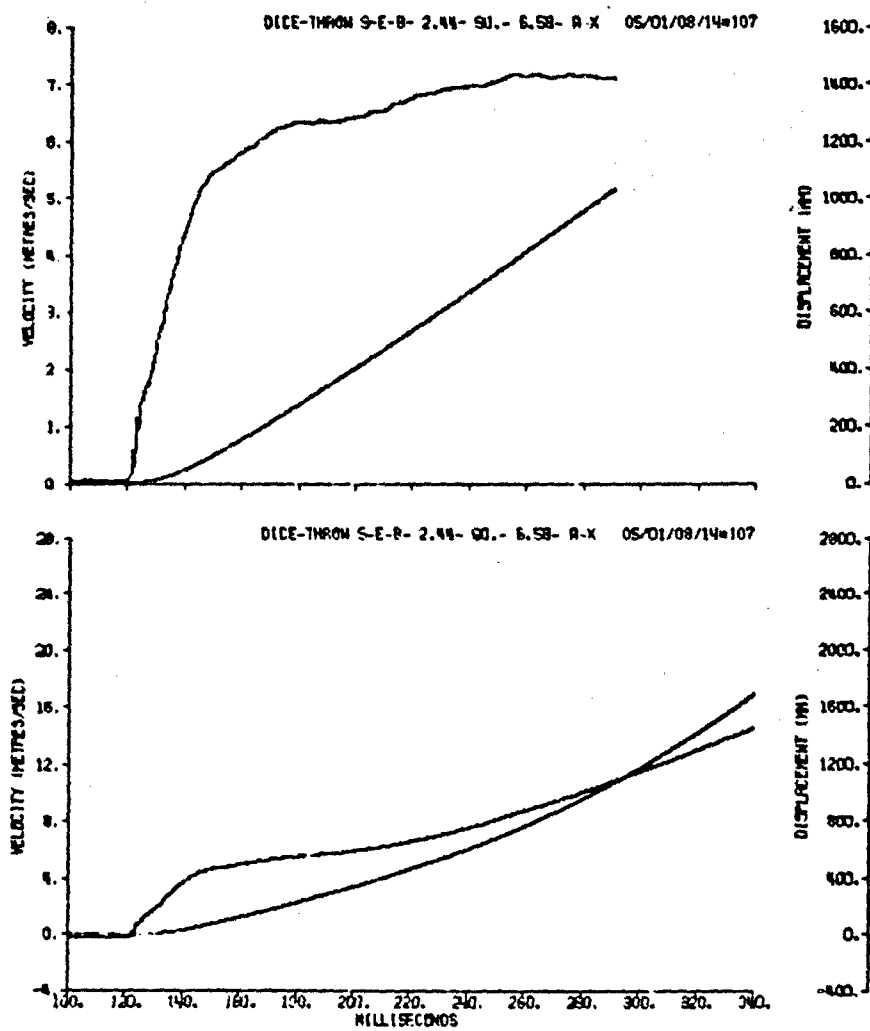




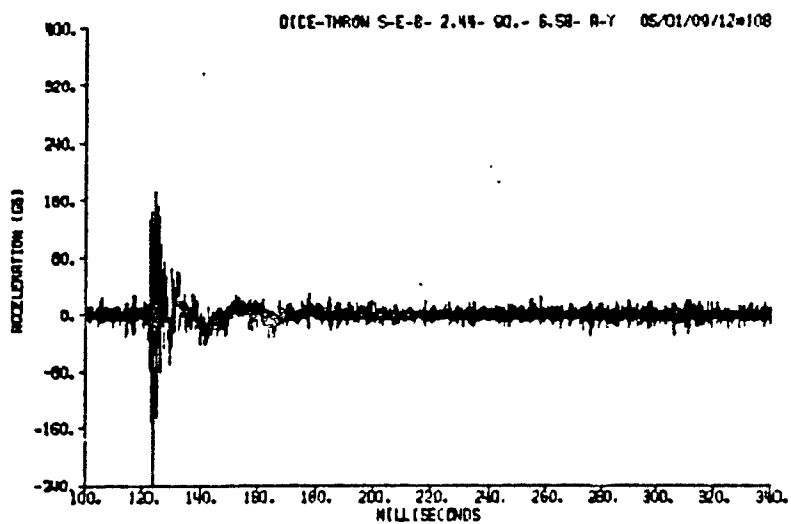
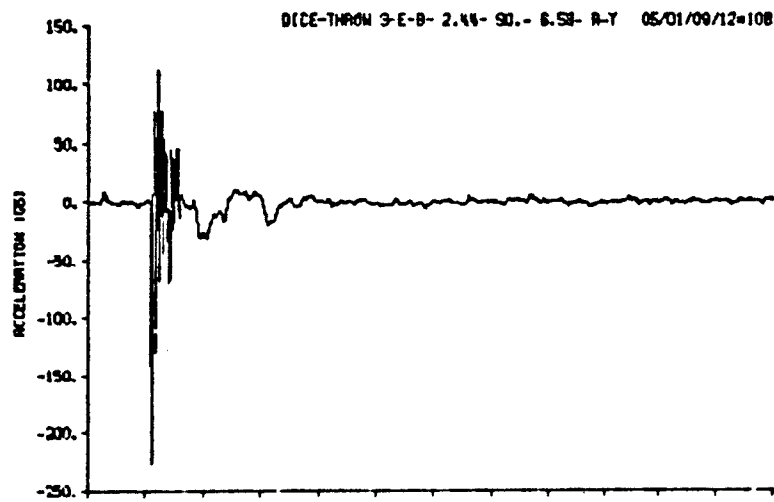
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AFWL-TR-77-001

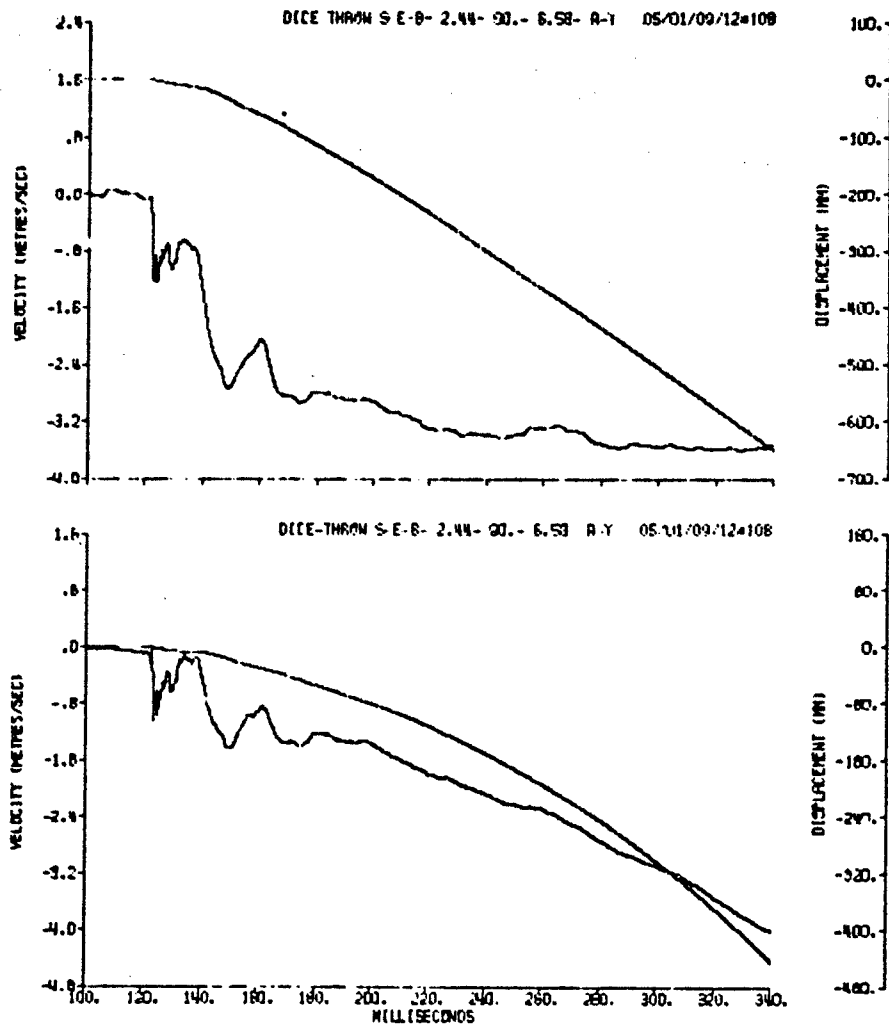


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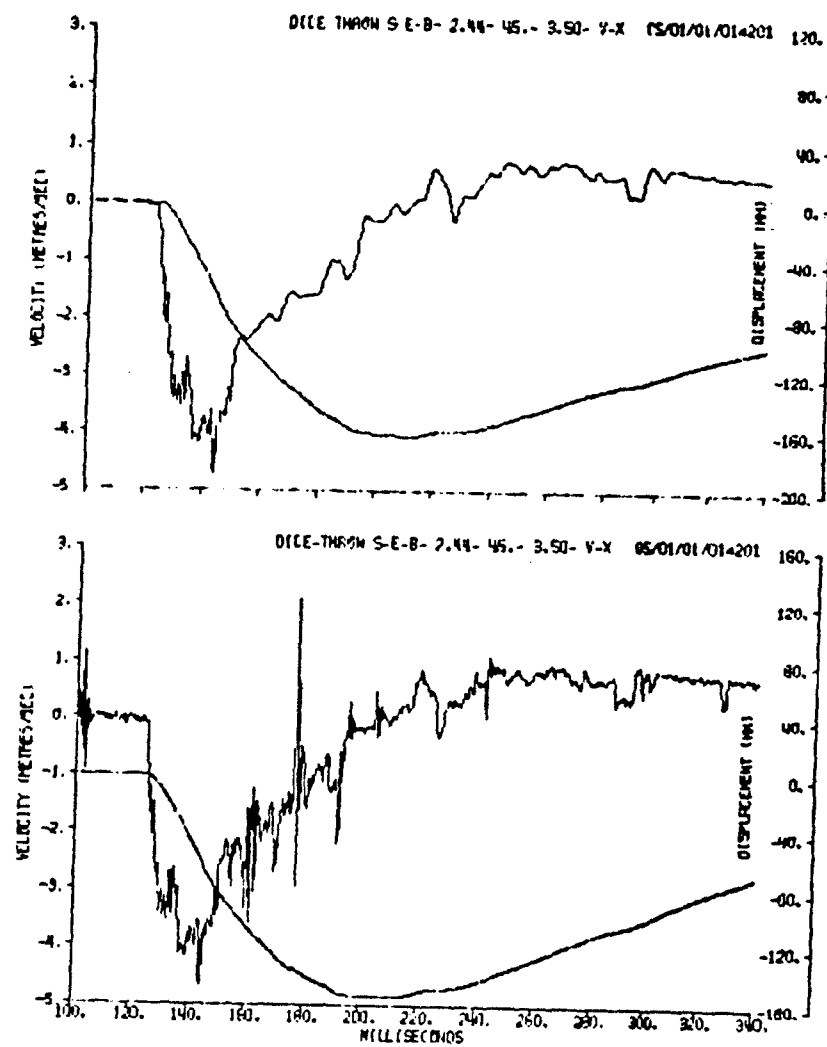


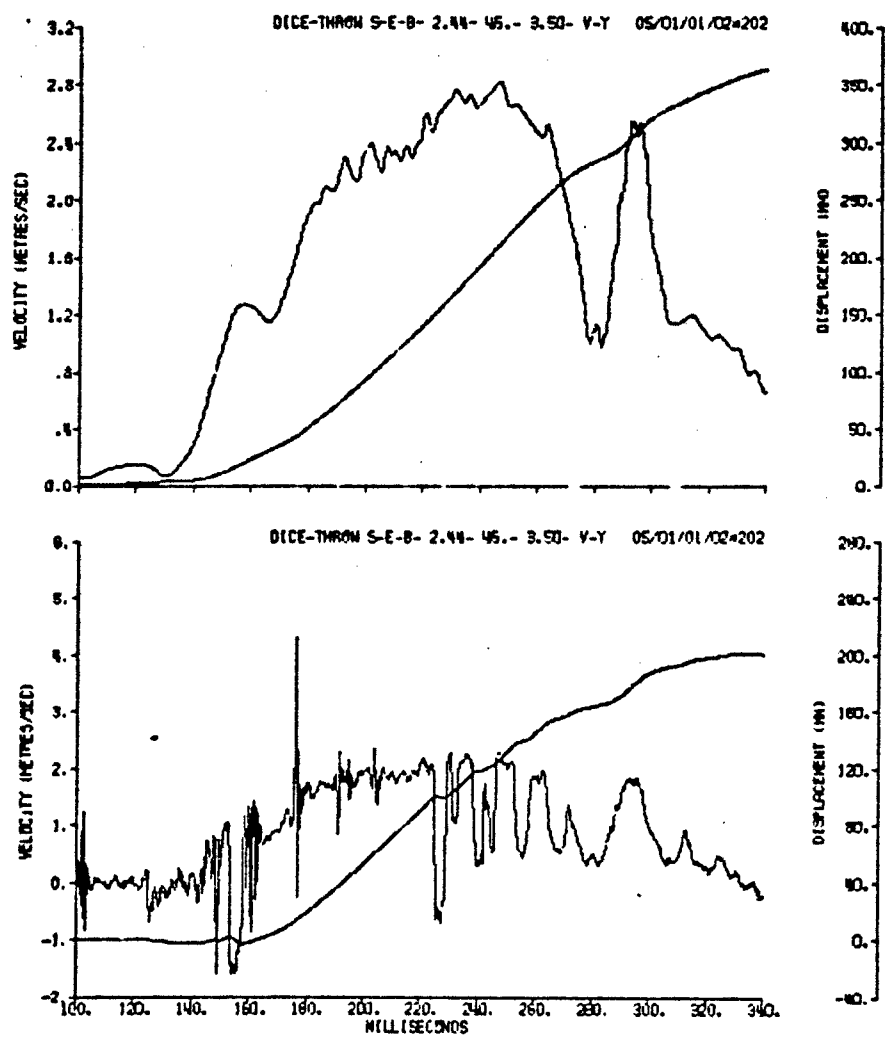


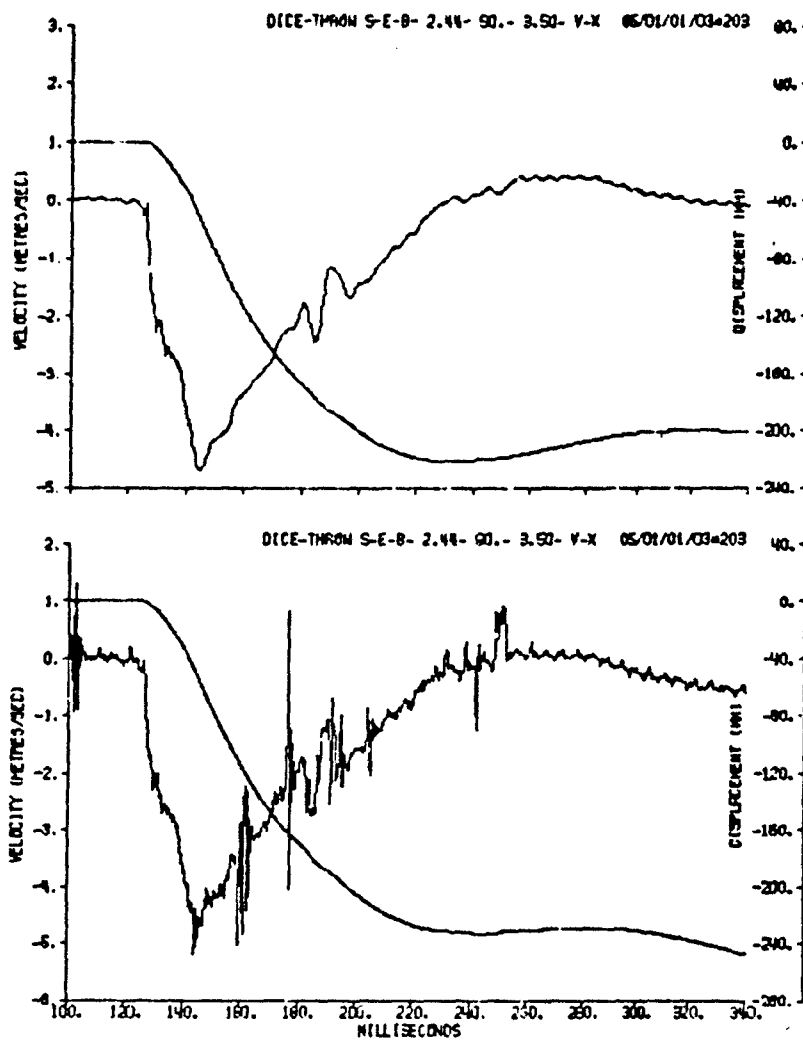
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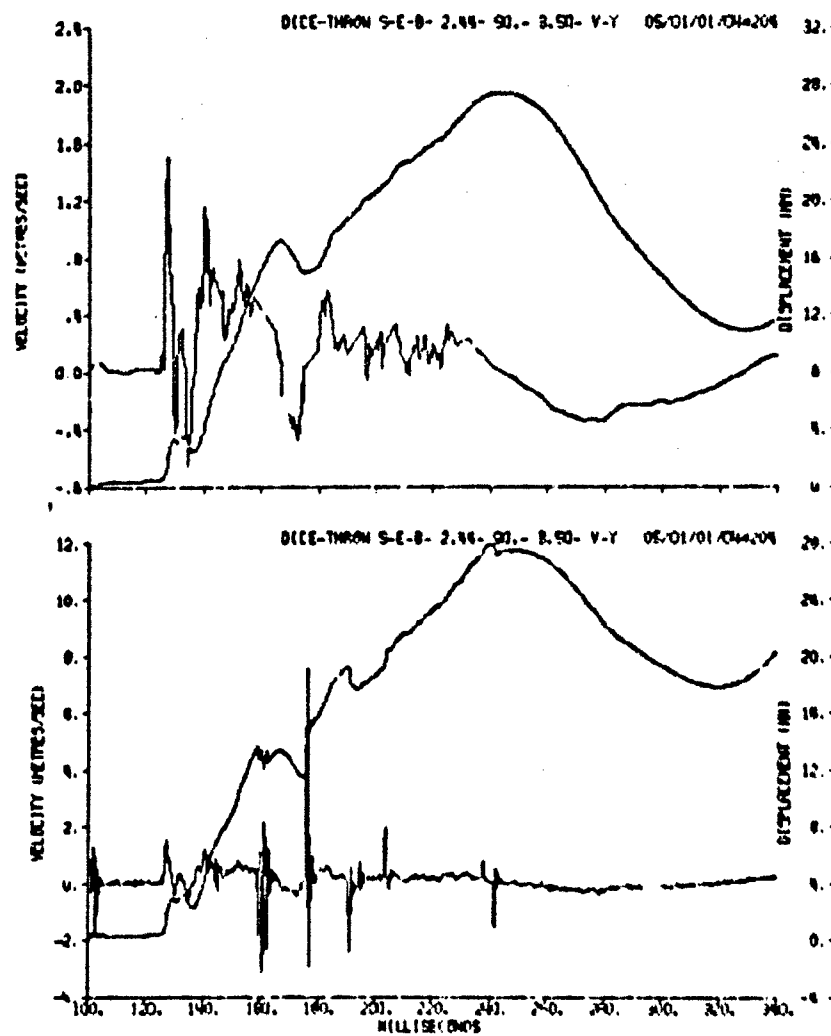
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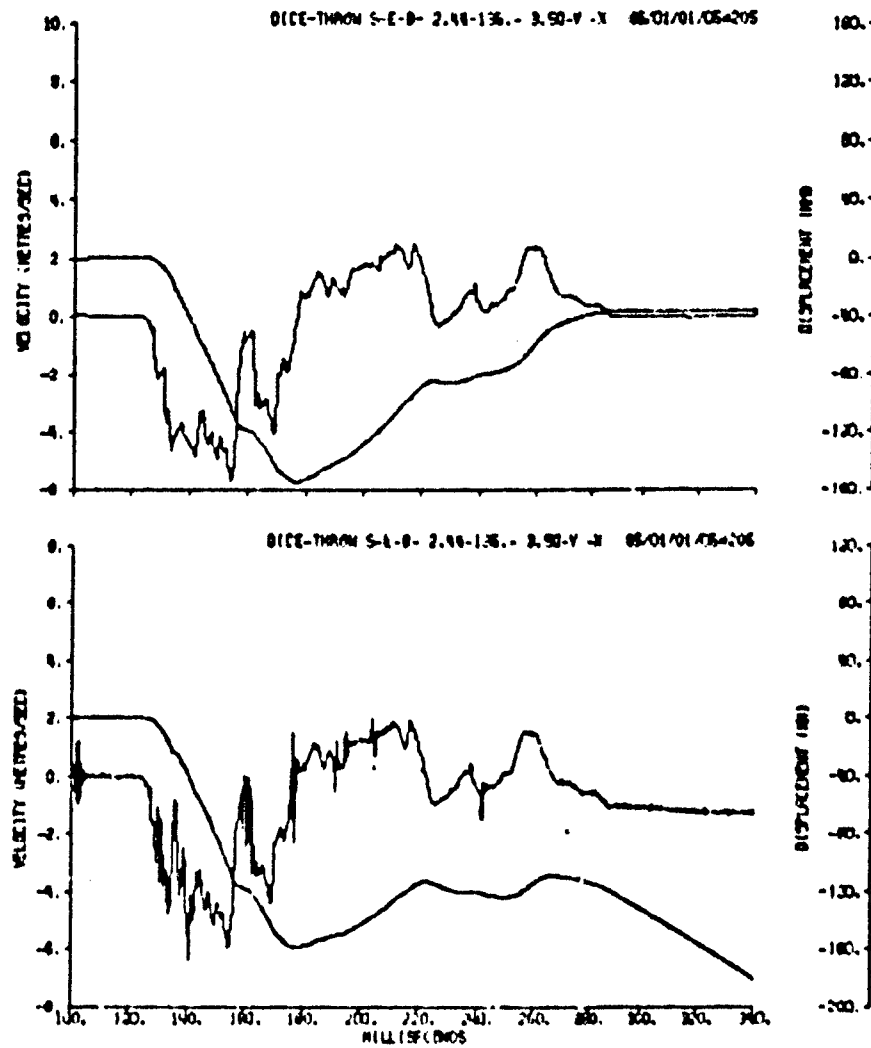




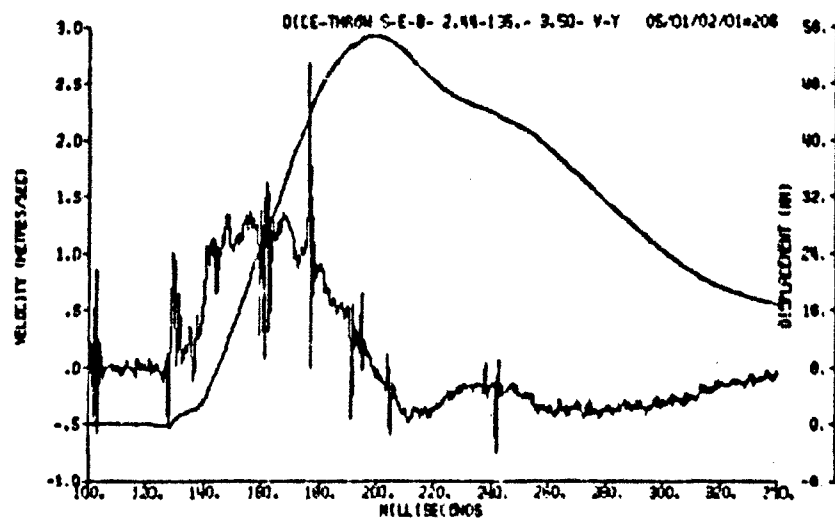
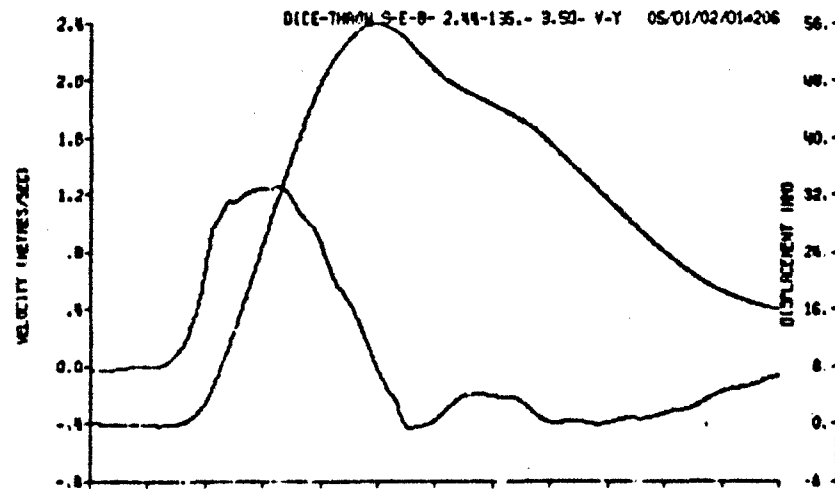


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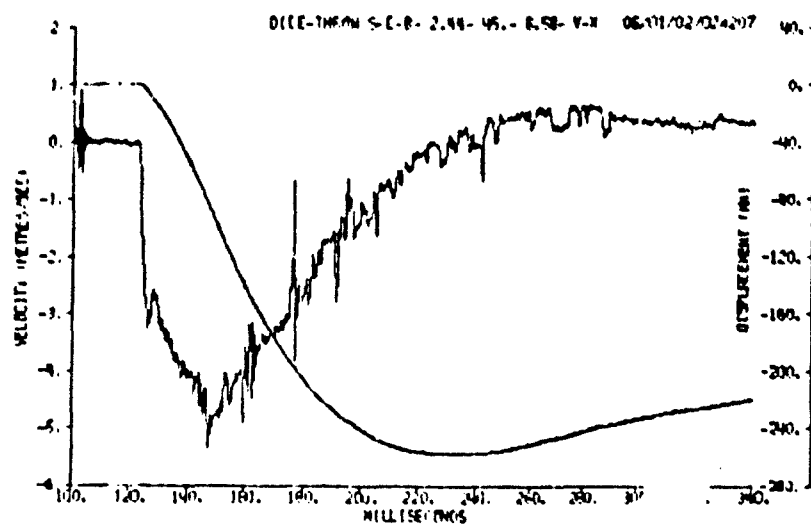
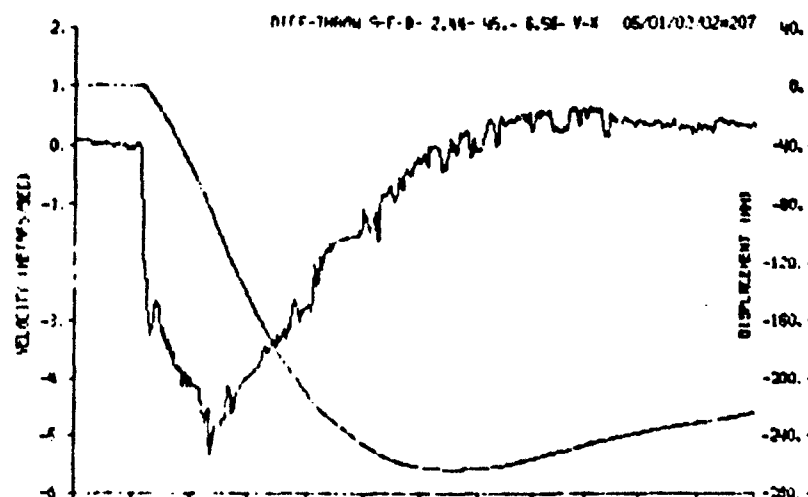




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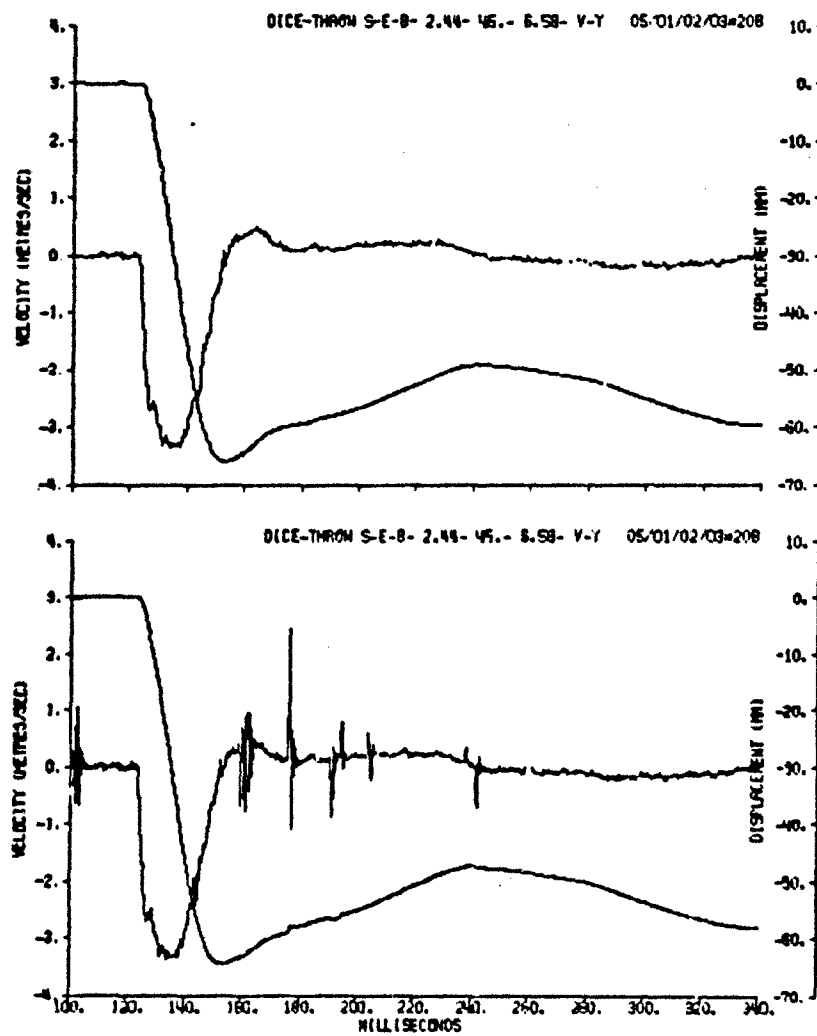


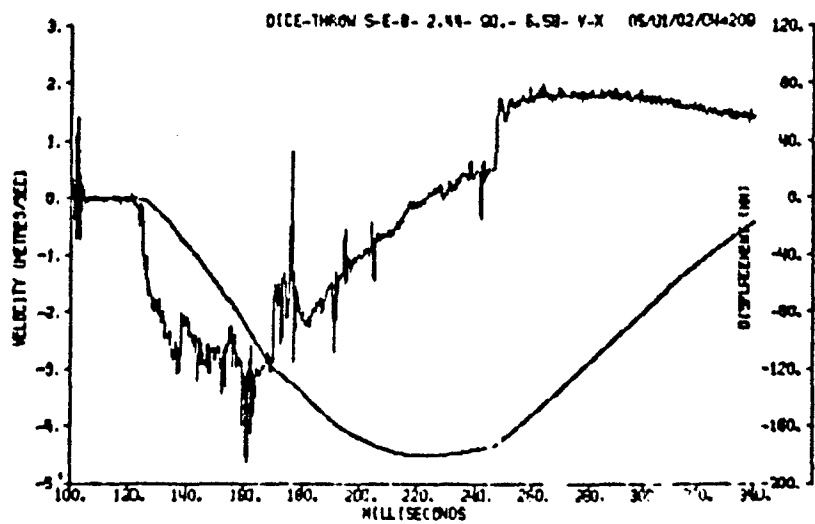
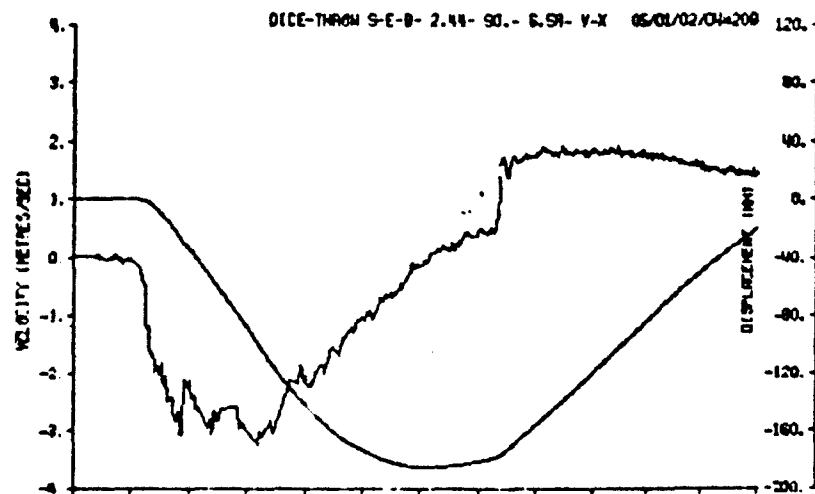
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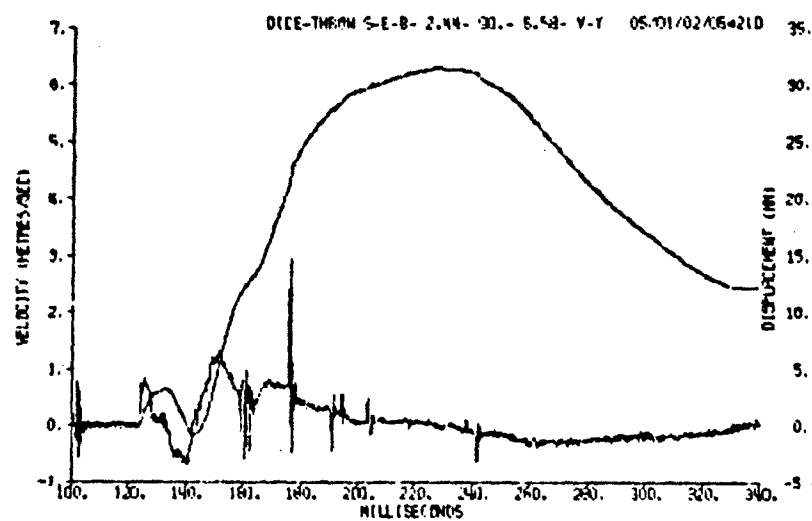
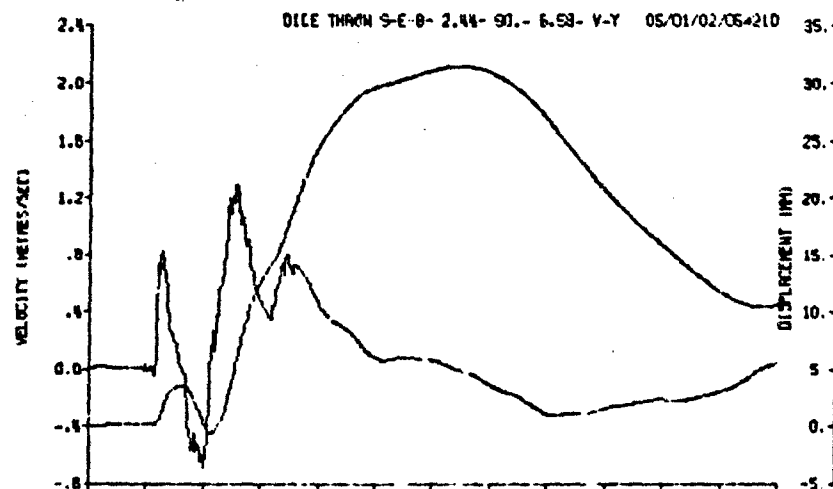


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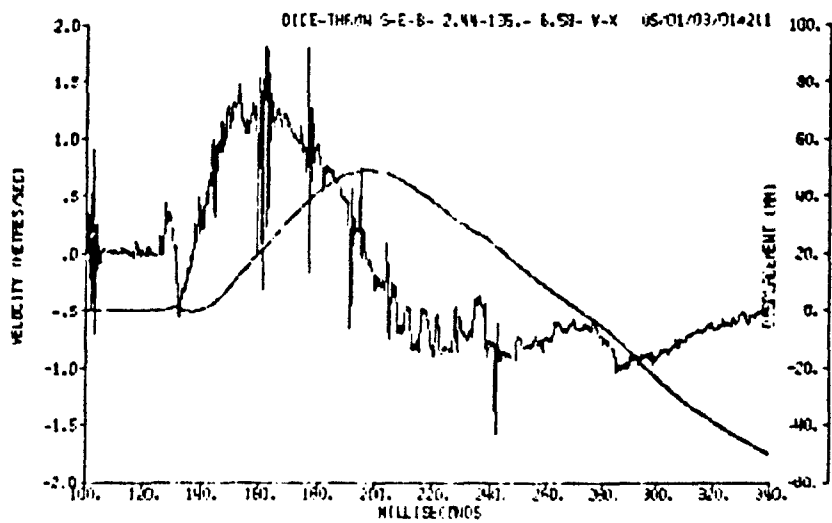
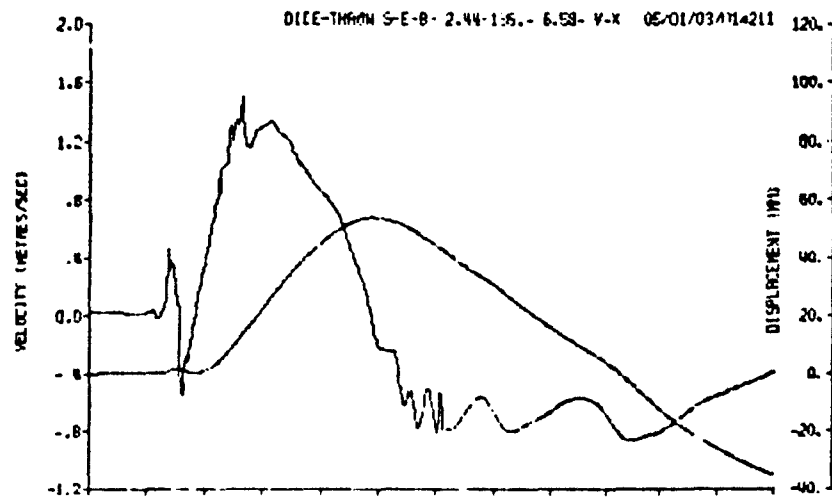




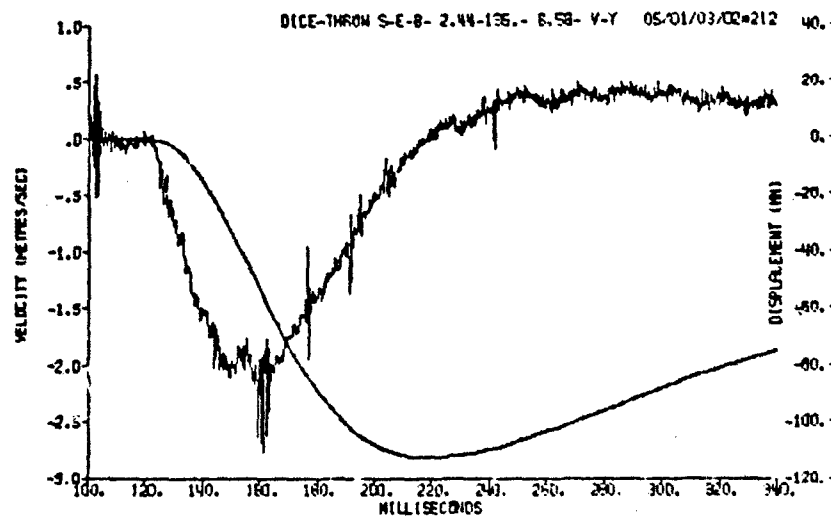
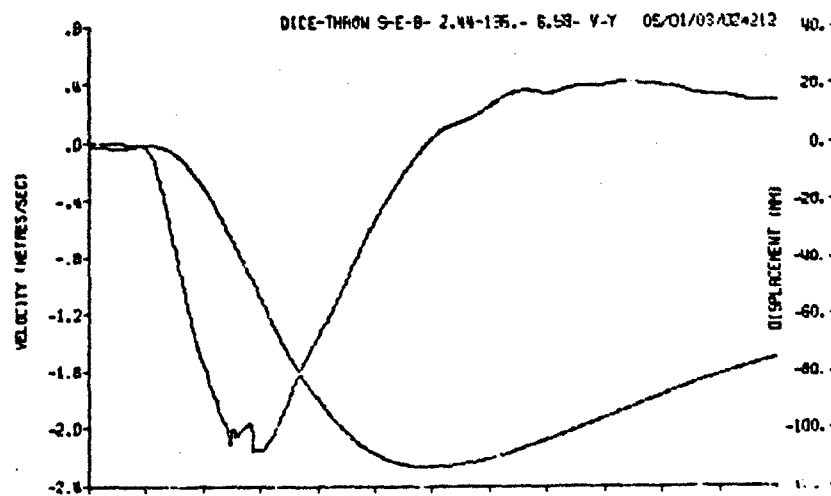
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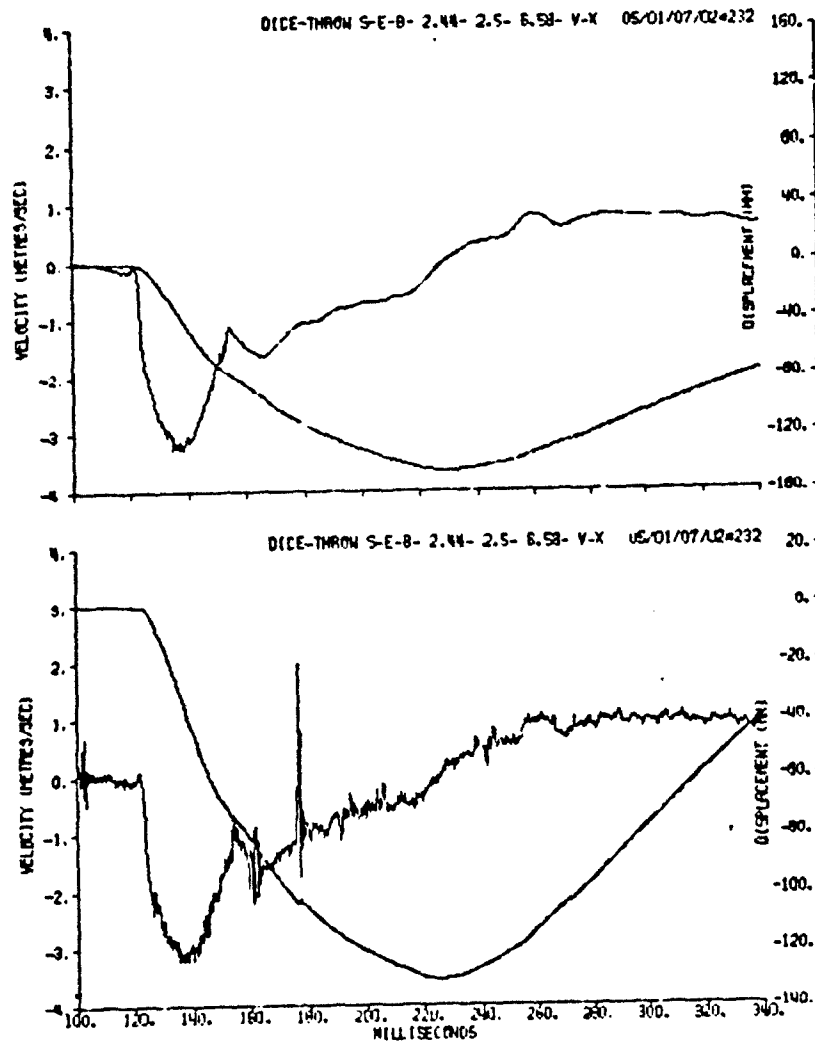
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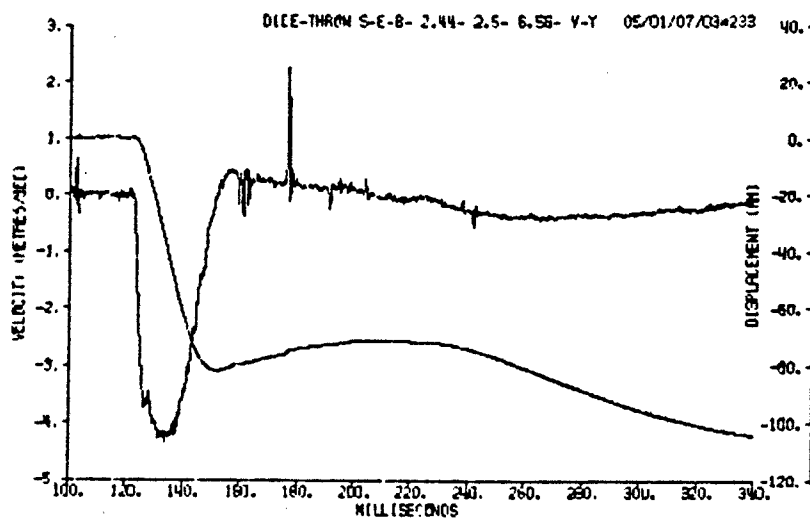
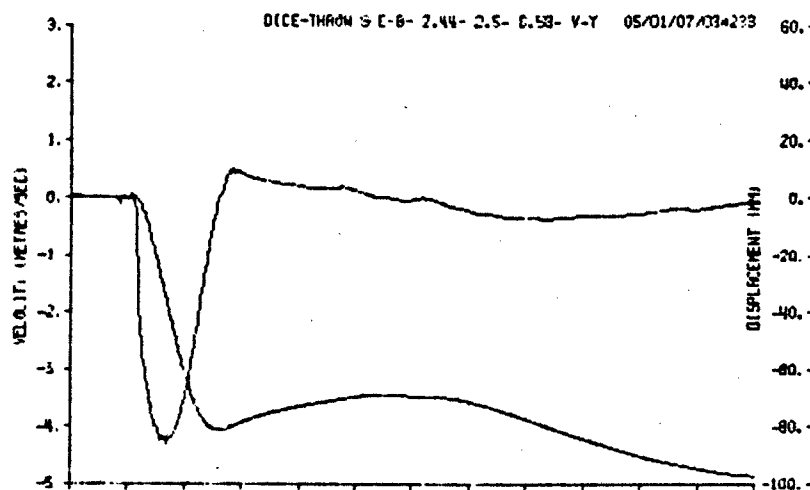


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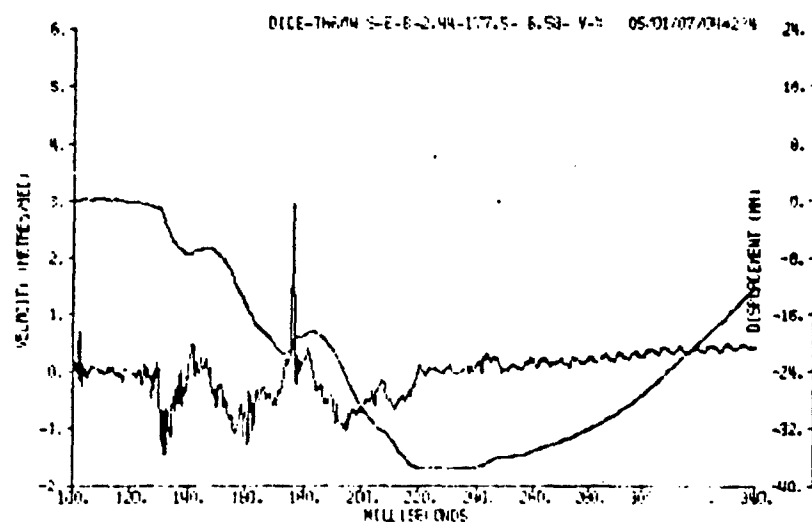
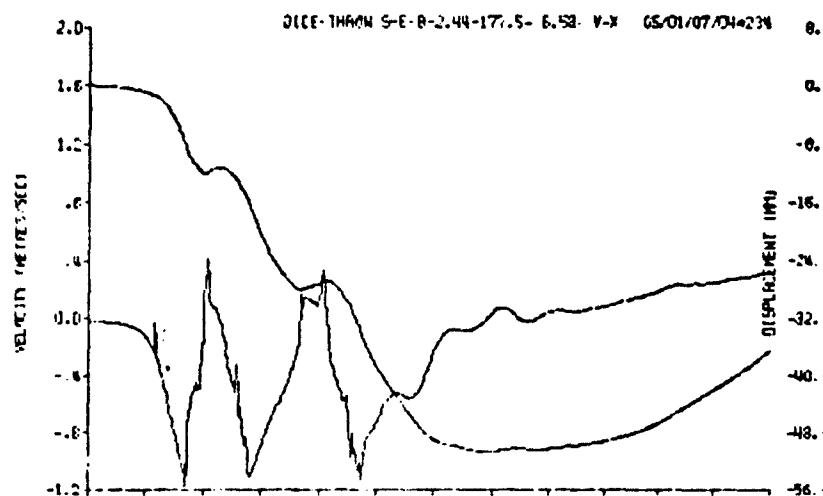


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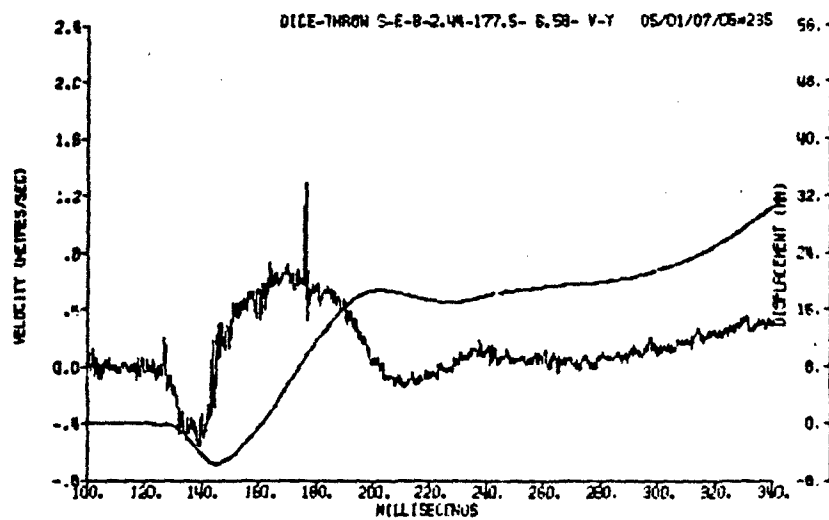
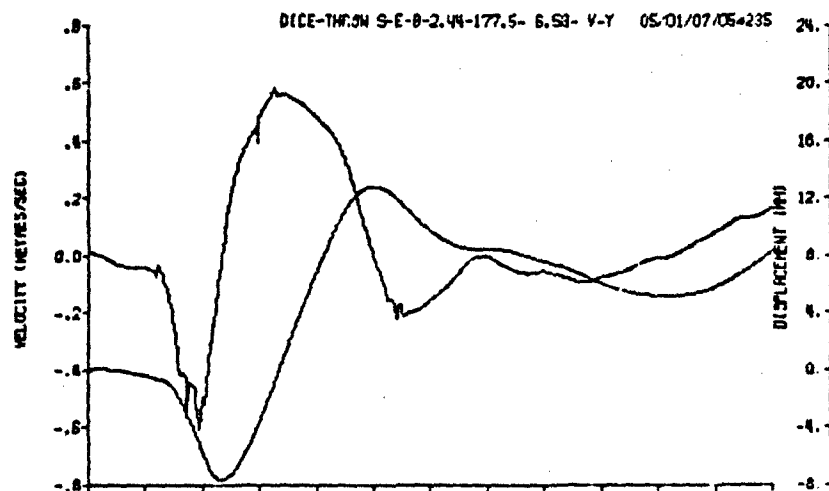


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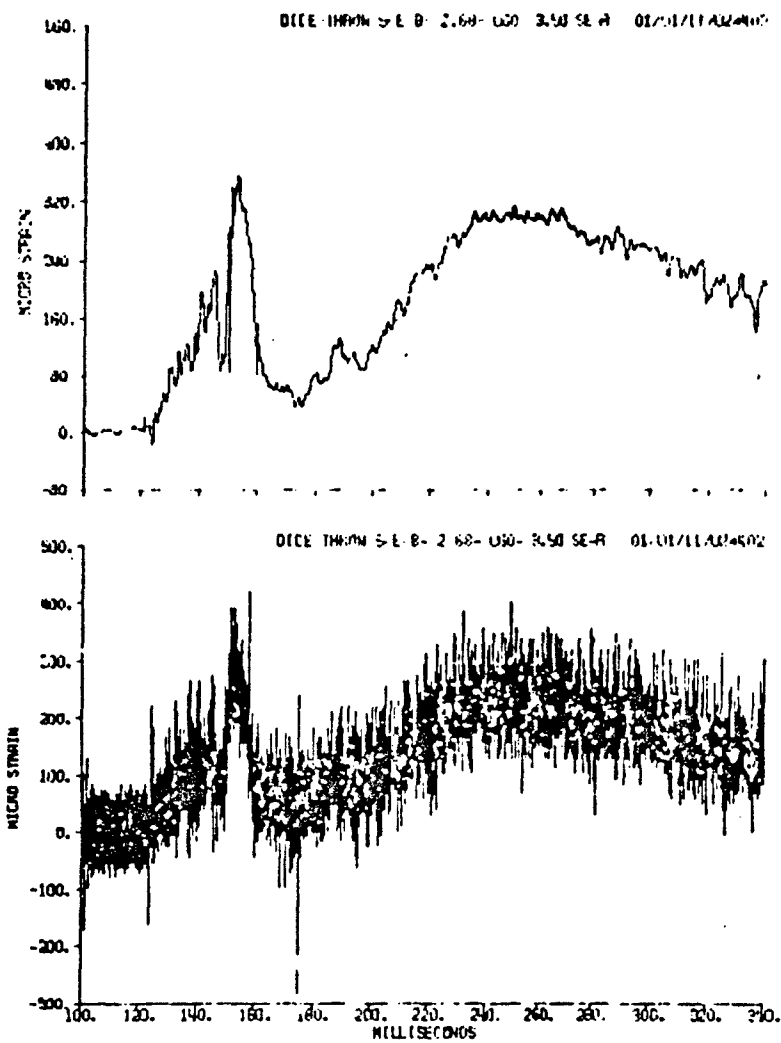




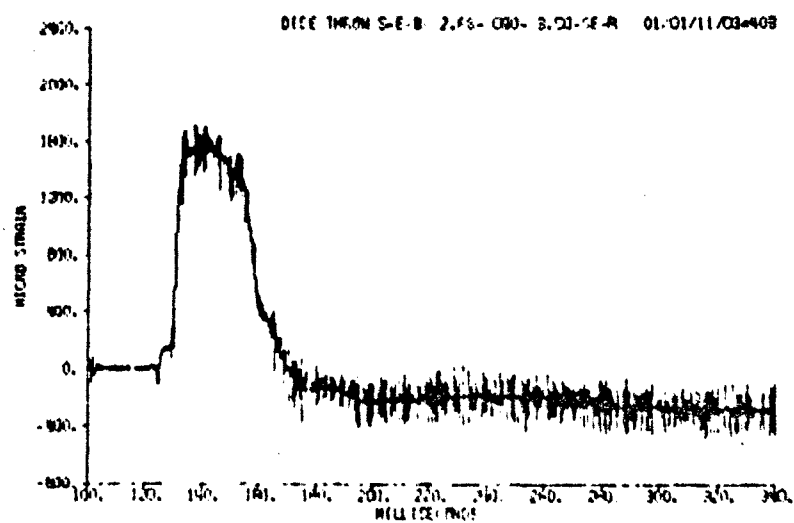
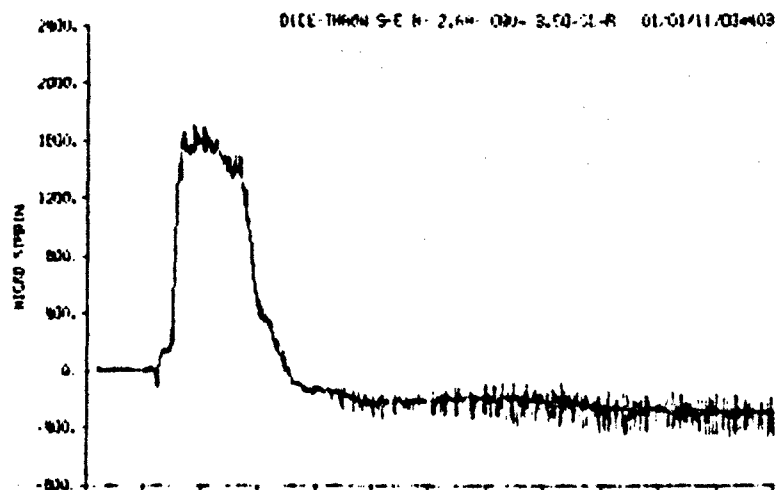
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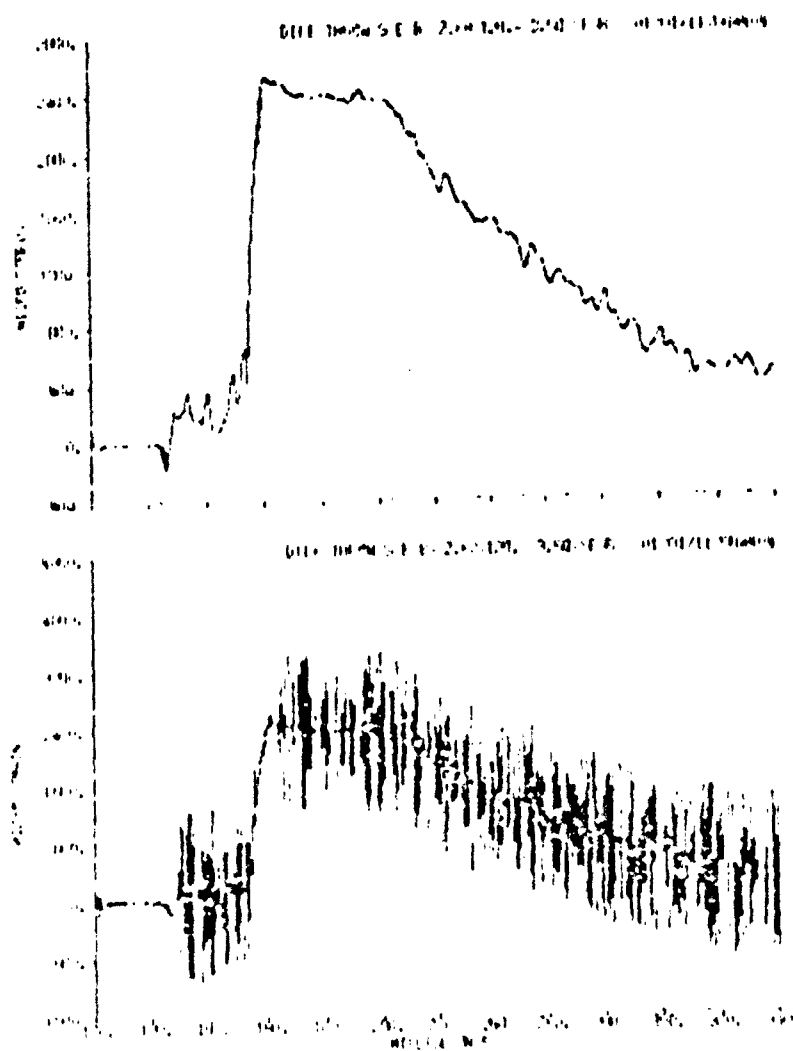
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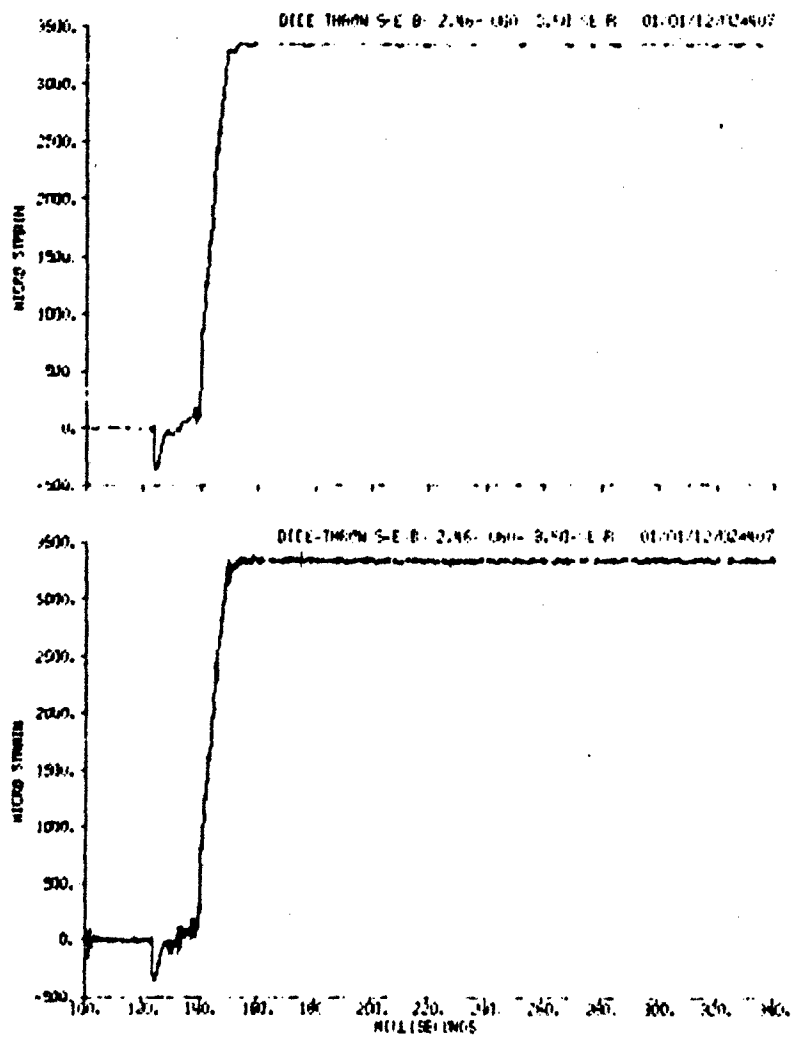
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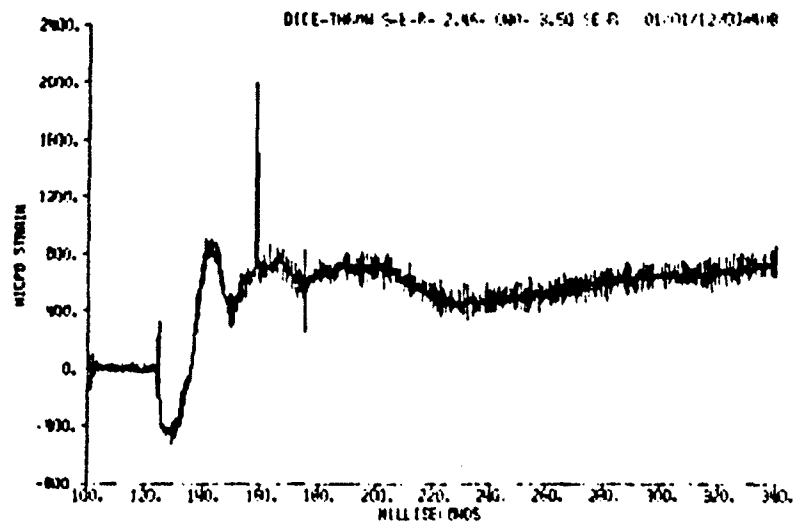
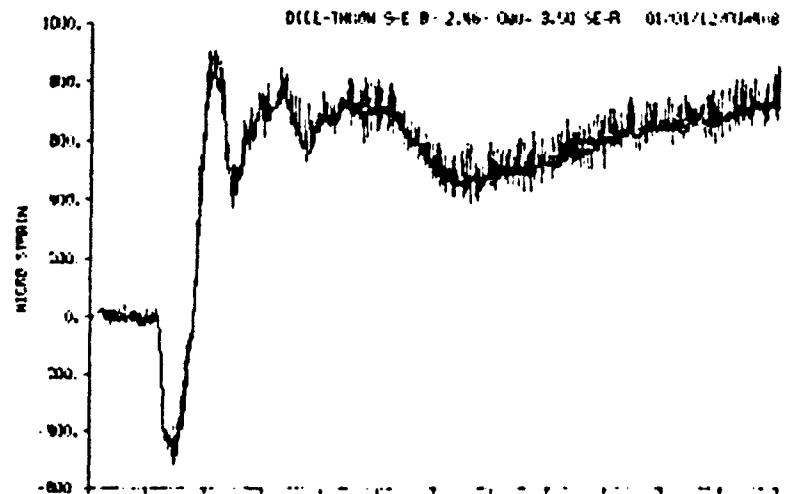
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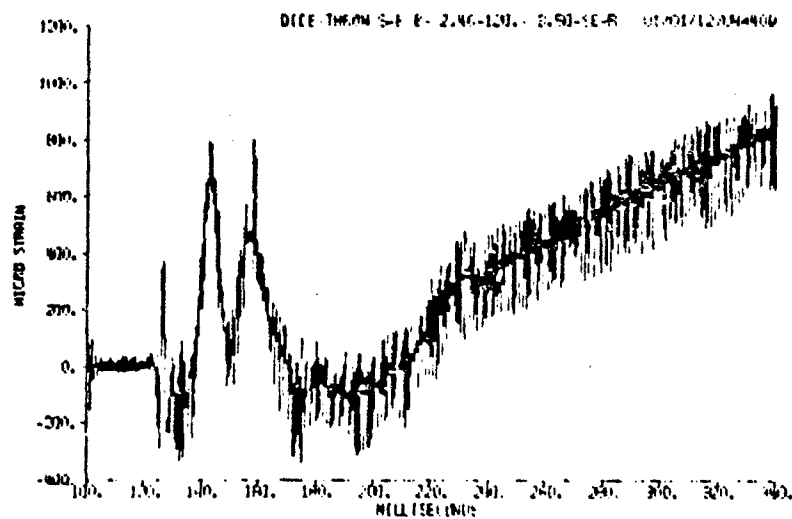
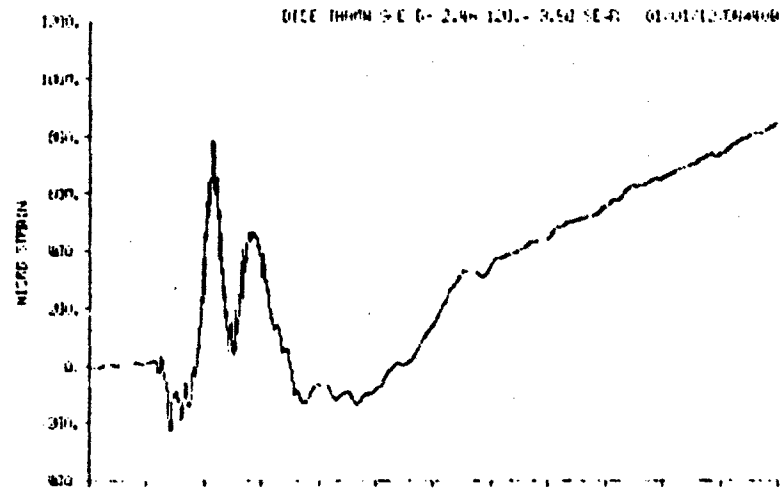
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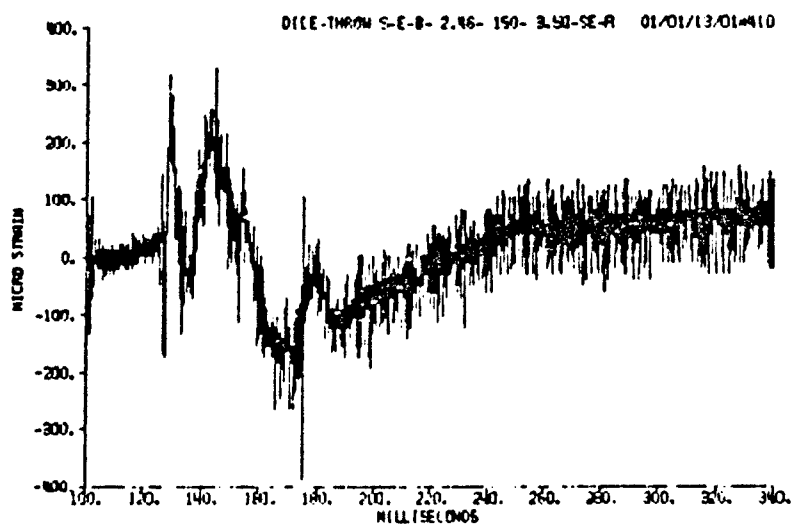
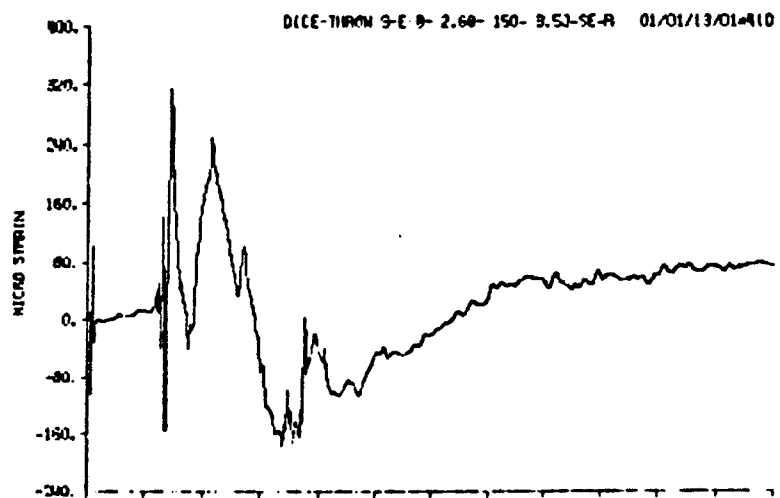
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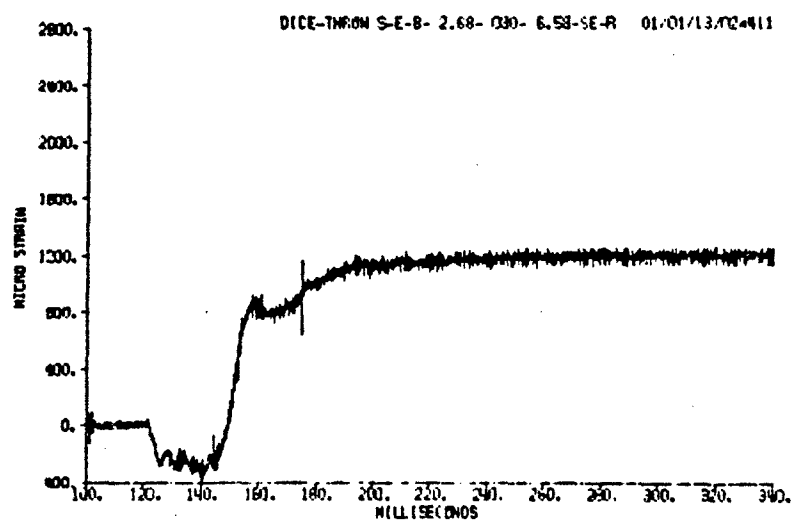
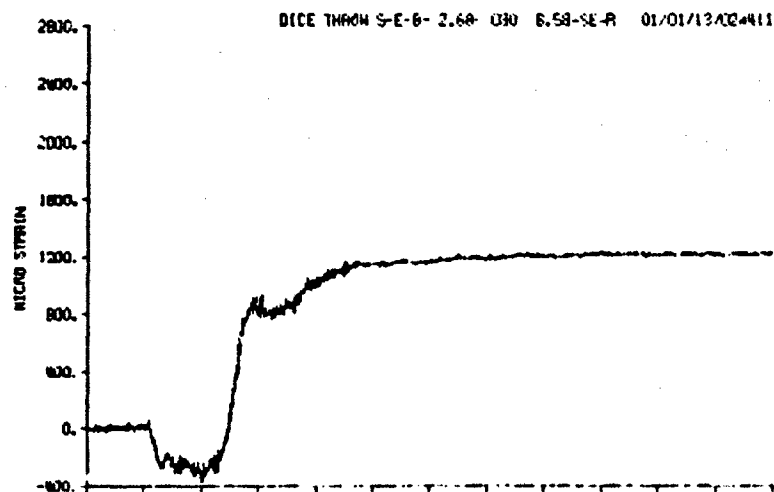


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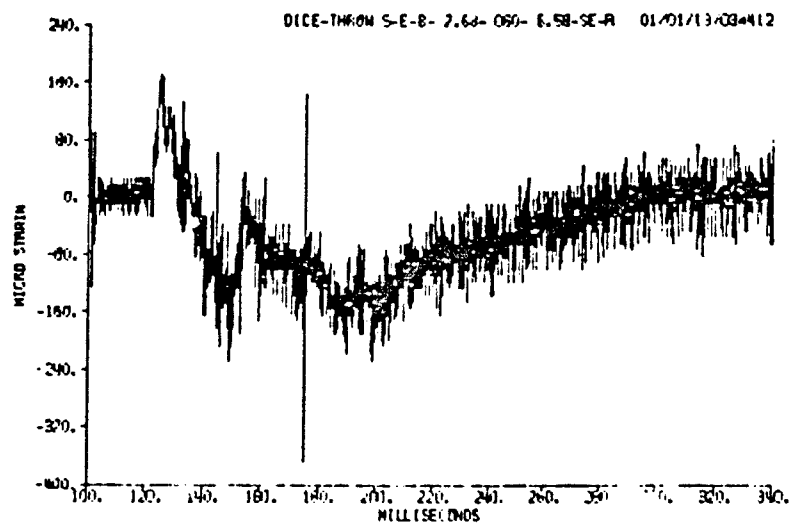
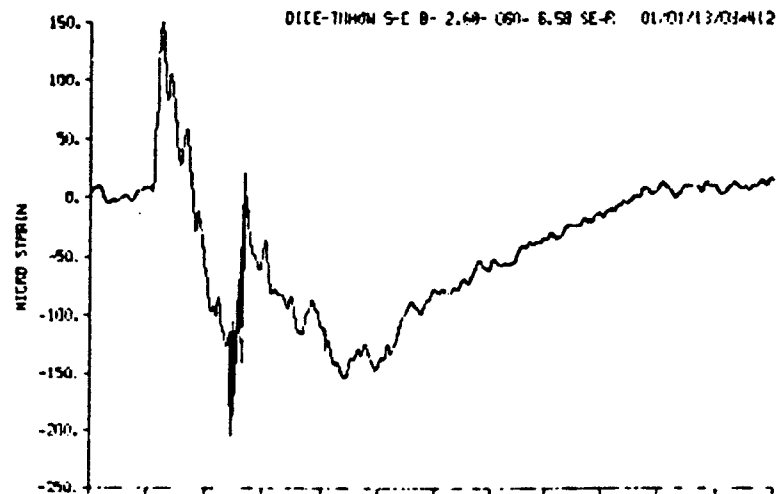




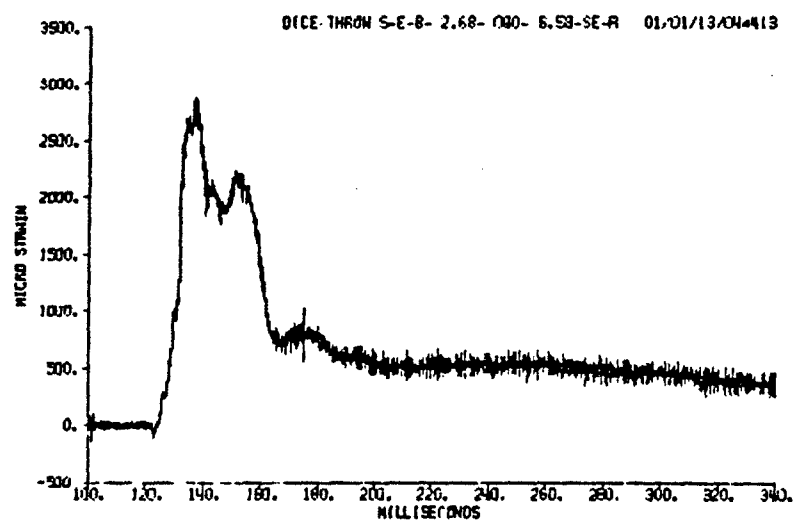
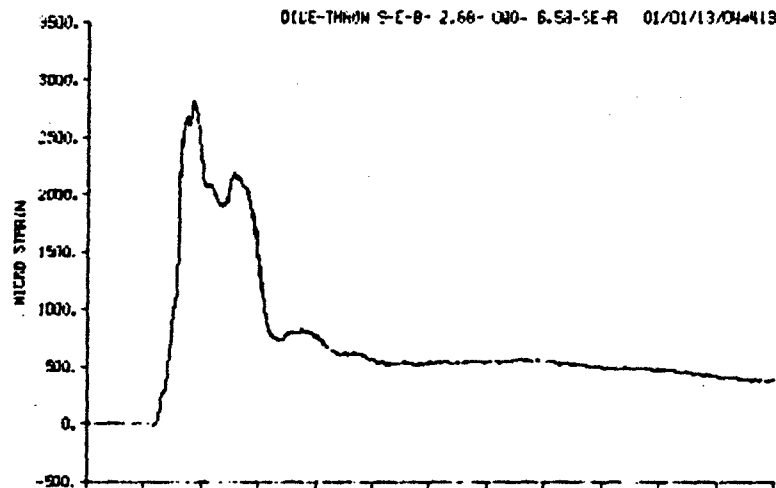
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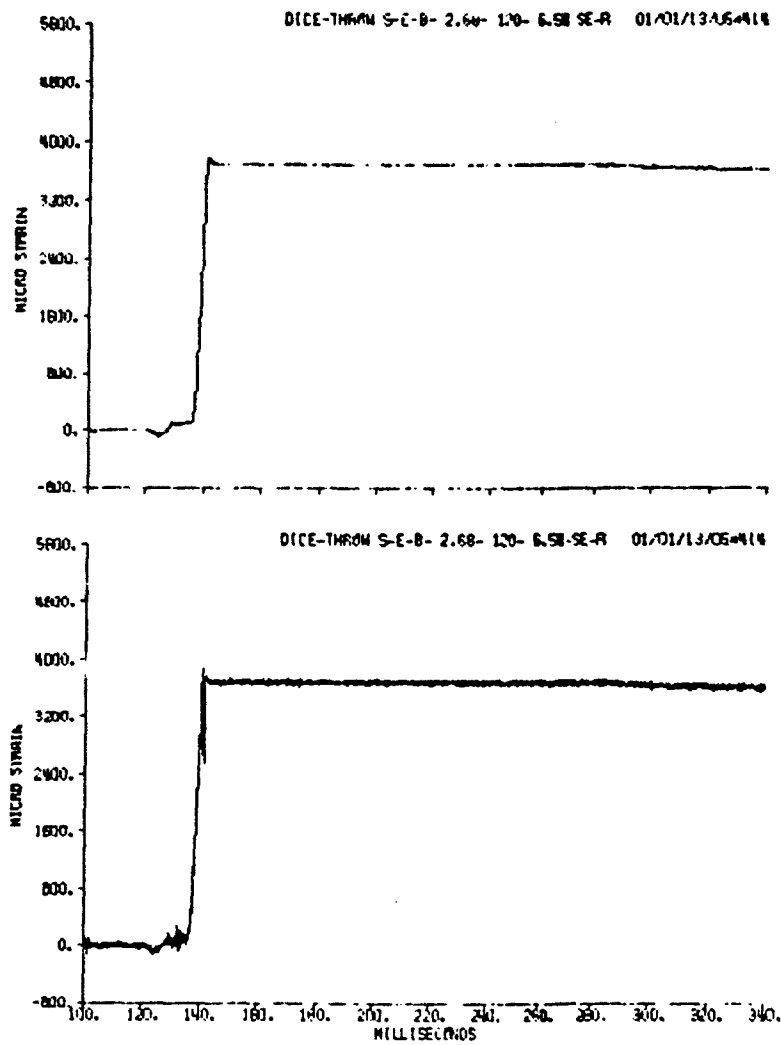
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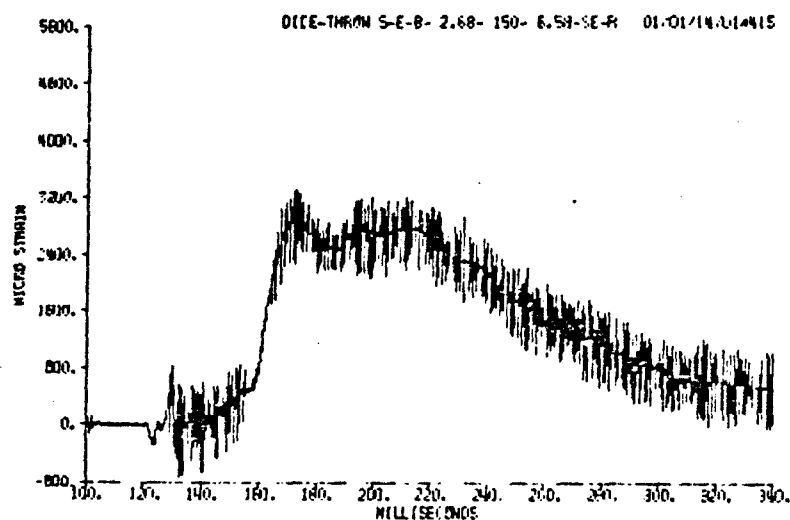
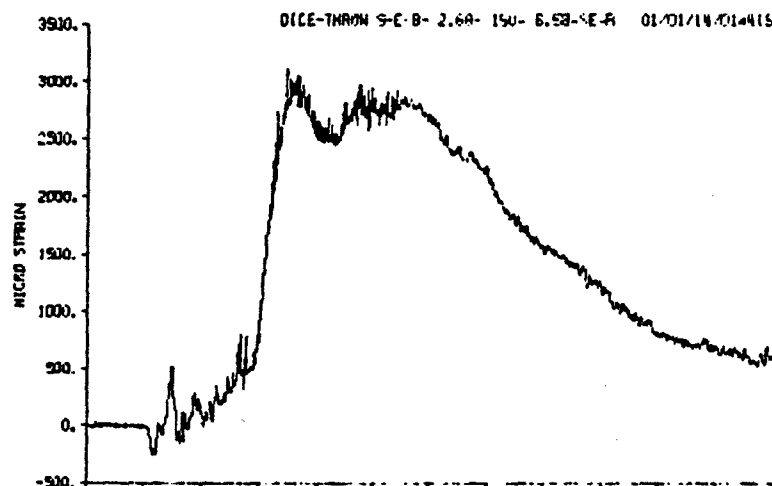
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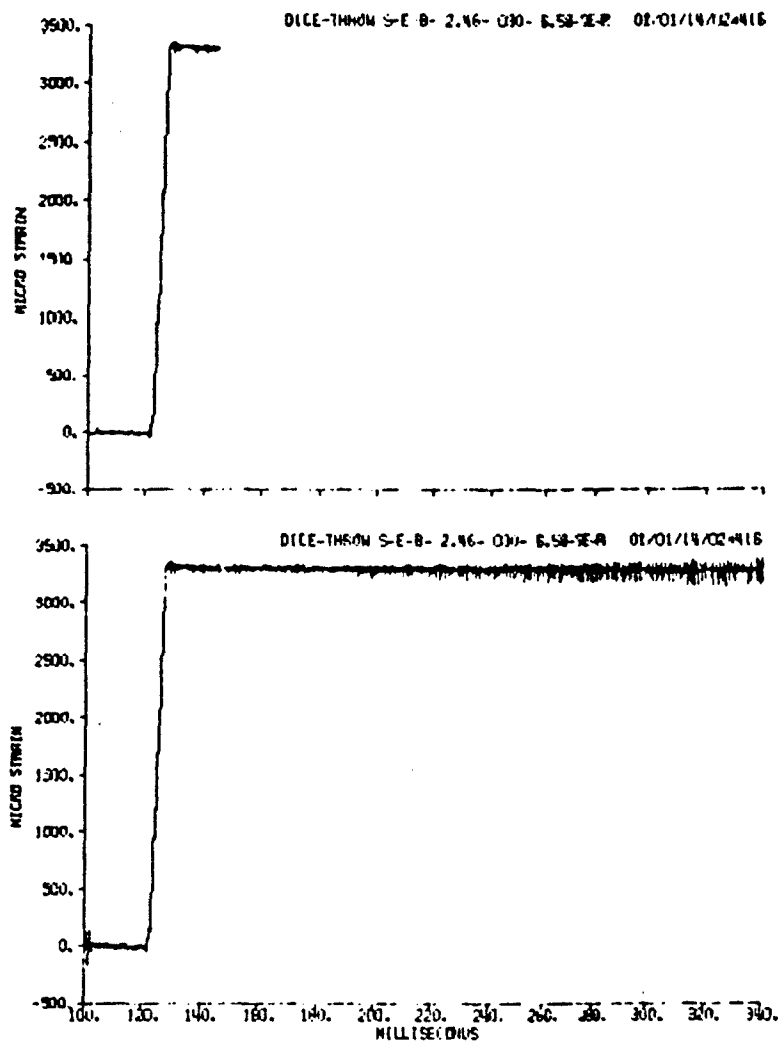
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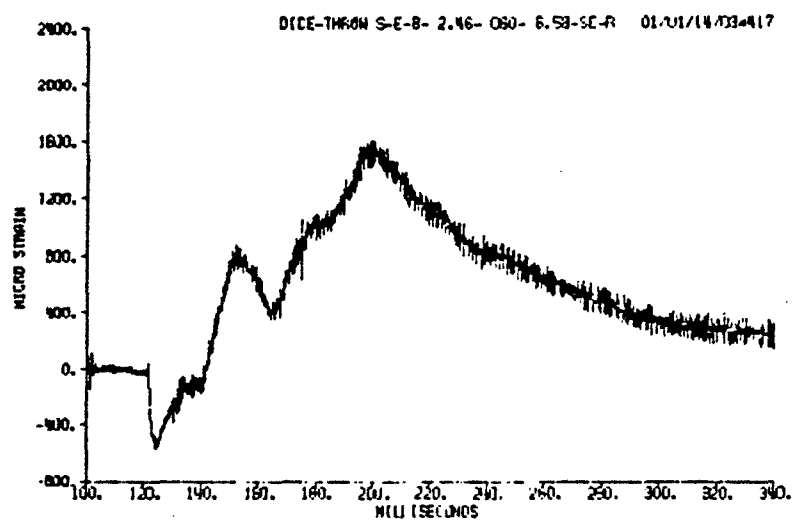
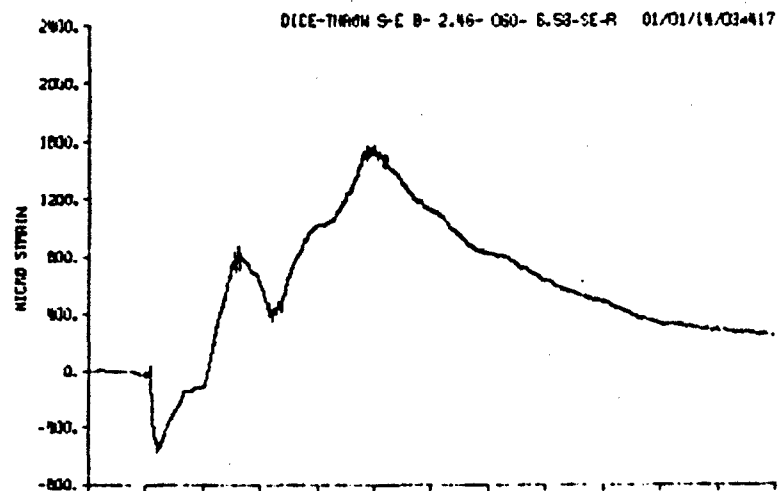
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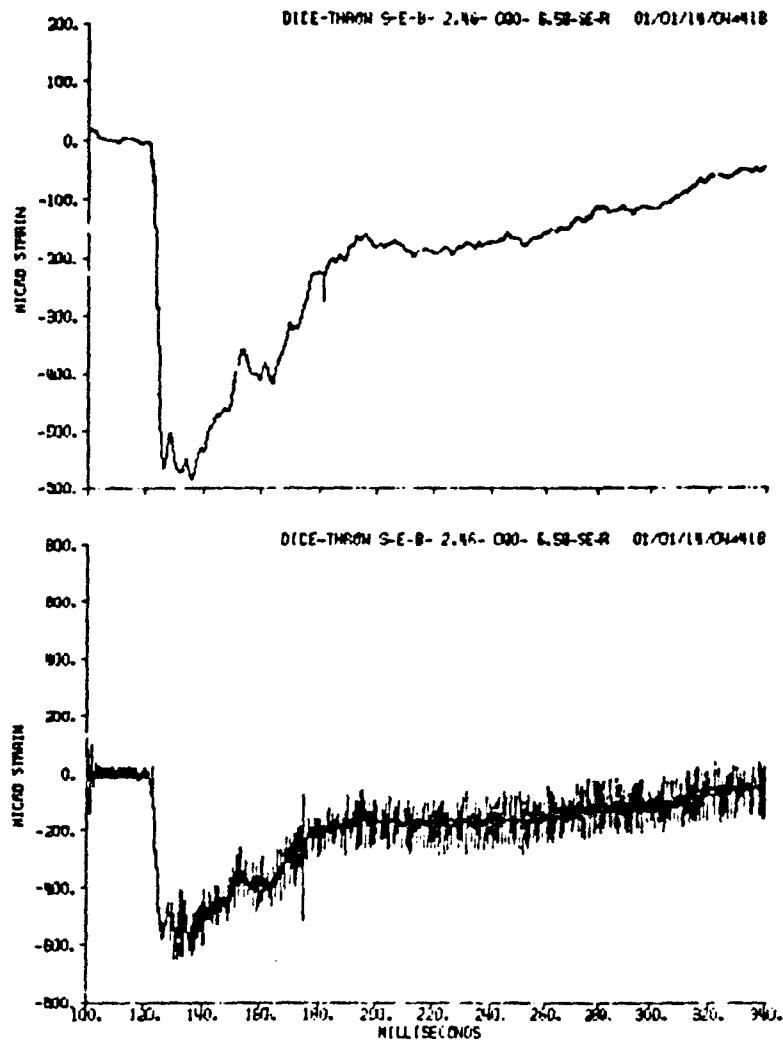
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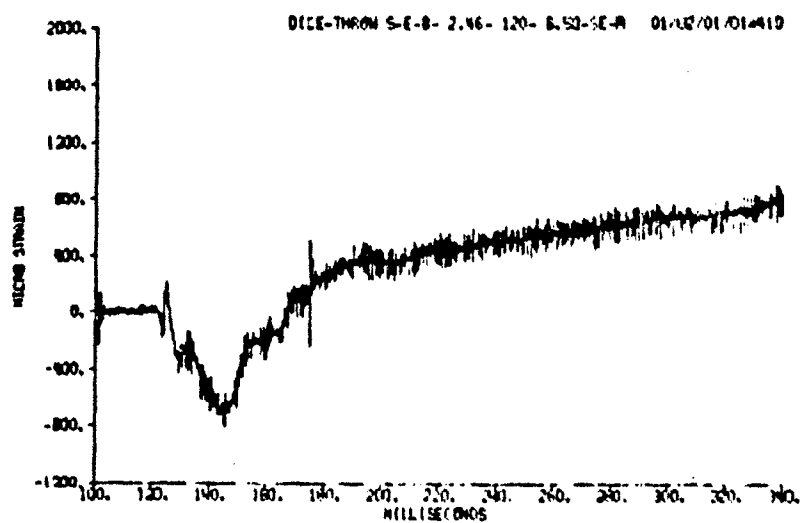
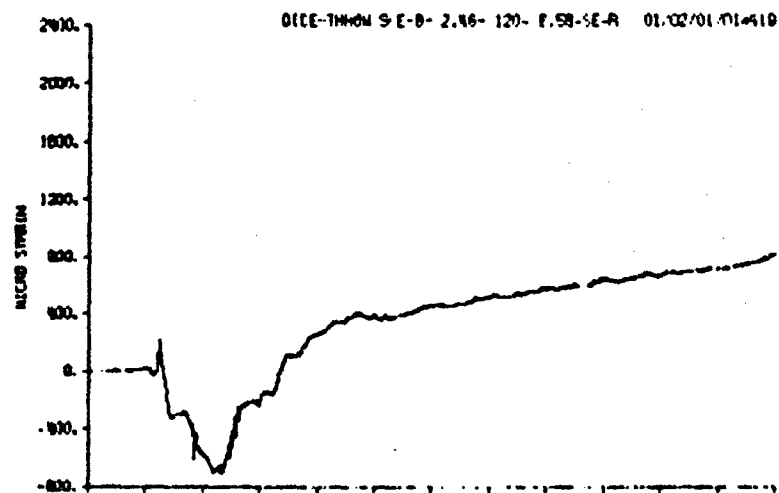


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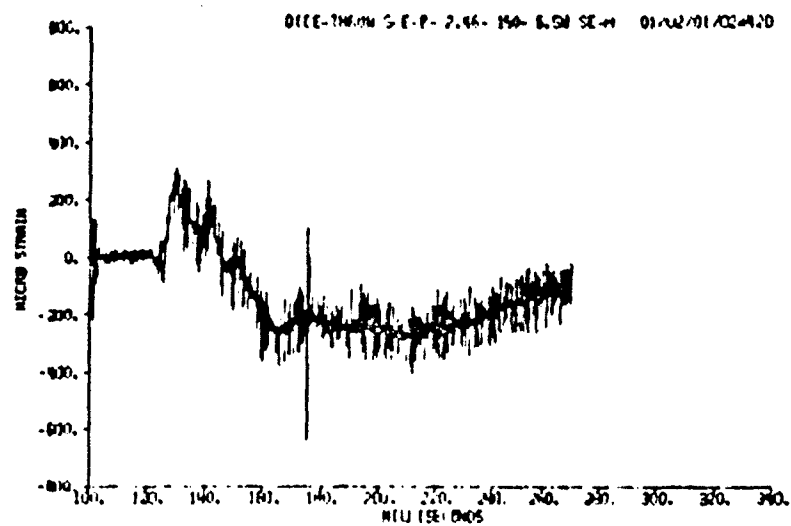
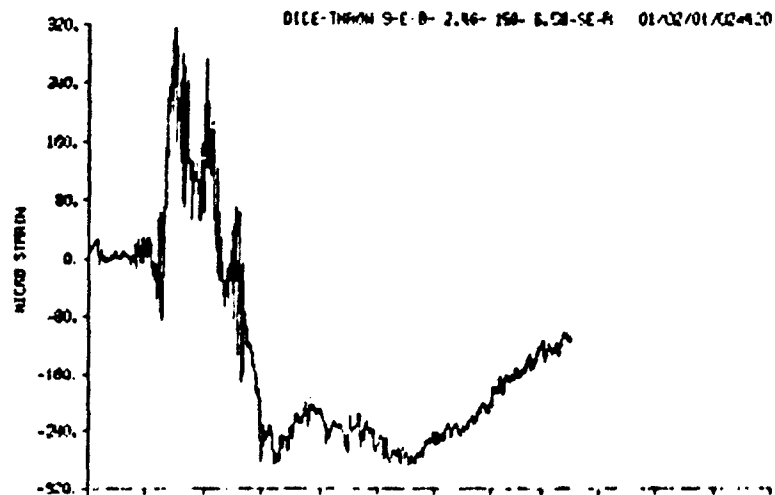




AFWL-TR-77-001



AFWL-TR-77-001



AFWL-TR-77-001

APPENDIX F  
AIRCRAFT SHELTER "C" DATA PRESENTATION

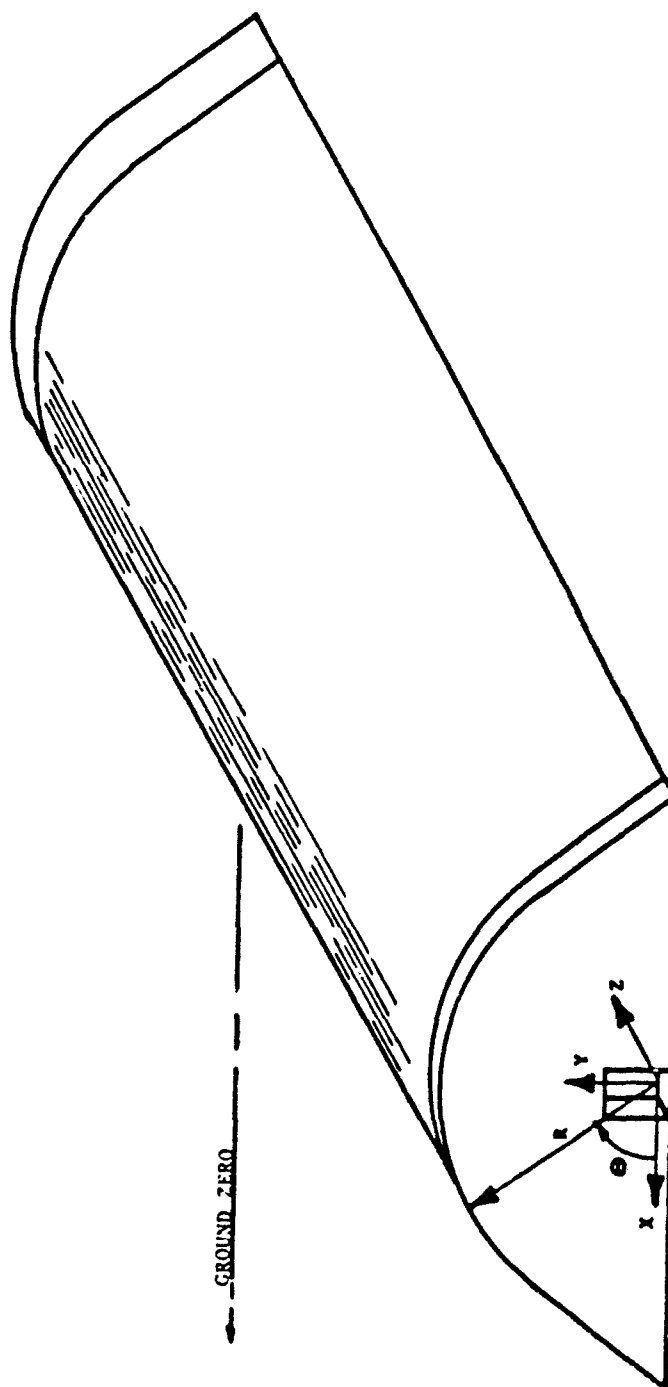


Figure F-1 Aircraft Shelter "C" Coordinate System

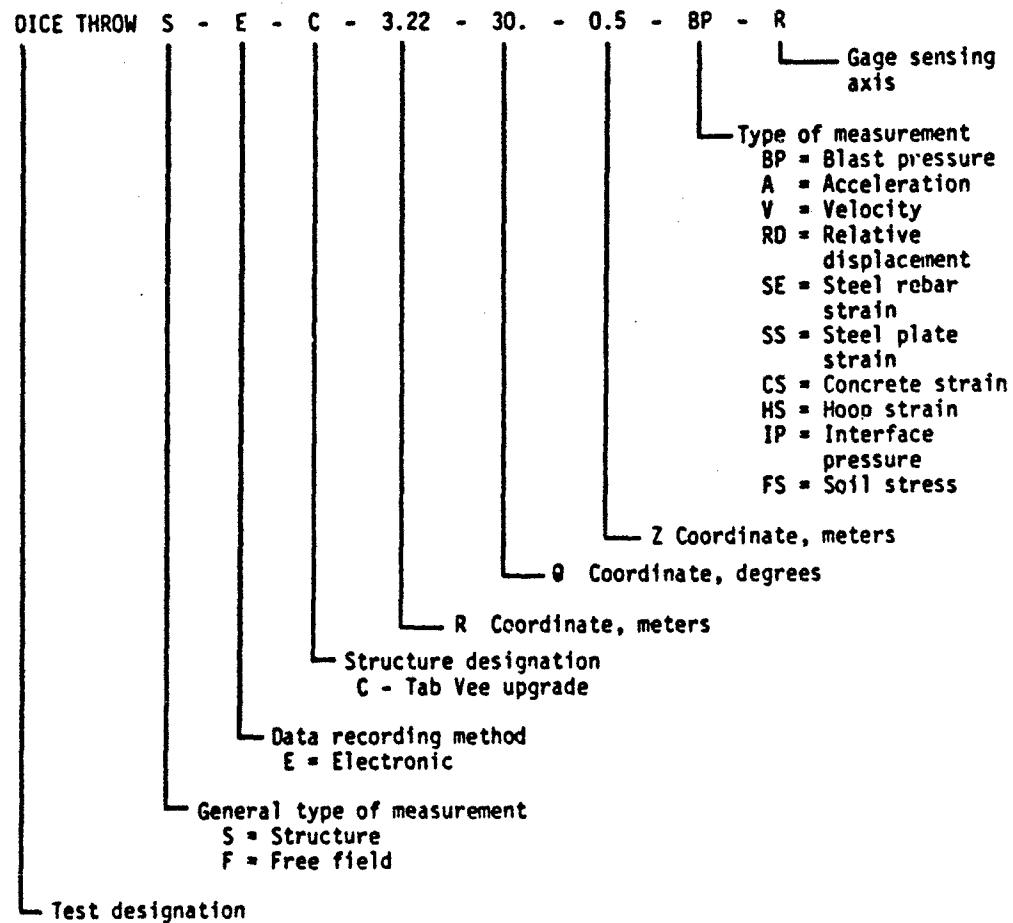


Figure F2. Measurement Designation System

DATA CORRECTIONS

DSP - points have been despiked.

SMT - a modified Hanning smooth has been performed.

FIL - a frequency cut-off or a band reject digital filter has been made.

BLC - the data has been baseline corrected.

INV - the polarity has been reversed.

On each page, the corrected plot is at the top and the uncorrected plot is at the bottom. Each acceleration plot is followed by its integral.

## DICE THROW, SHELTER C DATA CORRECTIONS

## COORDINATES

MEAS. NO.	R METERS	θ DEGREES	Z METERS	MEAS. TYPE	SENS. AXIS	DATA CORRECTIONS	GENERAL LOCATIONS
015	3.81	2.5	0.5	BP	R	DSP, SMT, BLC	Outer Surf/Outer Edge
016	3.22	30	0.5	BP	R	DSP, SMT	Outer Surf/Outer Edge
017	3.21	60	0.5	BP	R	DSP, SMT, BLC	Outer Surf/Outer Edge
018	3.21	90	0.5	BP	R	DSP, SMT, BLC	Outer Surf/Outer Edge
019	3.21	120	0.5	BP	R	DSP, SMT, FIL, BLC	Outer Surf/Outer Edge
020	3.22	150	0.5	BP	R	DSP, BLC	Outer Surf/Outer Edge
021	3.81	177.5	0.5	BP	R	DSP, SMT	Outer Surf/Outer Edge
022	3.81	2.5	6.88	BP	R	DSP, SMT, BLC	Outer Surf/Middle of Struc
023	3.22	30	6.58	BP	R	DSP, SMT	Outer Surf/Middle of Struc
024	3.21	60	6.58	BP	R	DSP, SMT	Outer Surf/Middle of Struc
025	3.21	90	6.88	BP	R	DSP, SMT	Outer Surf/Middle of Struc
026	3.21	120	6.58	BP	R	DSP, SMT, BLC	Outer Surf/Middle of Struc
027	3.22	150	6.58	BP	R	DSP, SMT, BLC	Outer Surf/Middle of Struc
028	3.81	177.5	6.88	BP	R	DSP, SMT, BLC	Outer Surf/Middle of Struc
109	2.44	45	6.58	A	X	DSP, SMT, BLC	Inner Surf/Middle of Struc
110	2.44	45	6.58	A	Y	DSP, SMT, BLC	Inner Surf/Middle of Struc
111	2.44	90	6.58	A	X	DSP, SMT	Inner Surf/Middle of Struc
112	2.44	90	6.58	A	Y	DSP, SMT, FIL, BLC	Inner Surf/Middle of Struc
213	2.44	45	3.50	V	X	DSP, SMT, BLC	Inner Surf/Near Super Struc
214	2.44	45	3.50	V	Y	DSP, SMT, BLC	Inner Surf/Near Super Struc
215	2.44	90	3.50	V	X	DSP, SMT	Inner Surf/Near Super Struc
216	2.44	90	3.50	V	Y	DSP, SMT, BLC	Inner Surf/Near Super Struc
217	2.44	135	3.50	V	X	DSP, SMT, BLC	Inner Surf/Near Super Struc
218	2.44	135	3.50	V	Y	DSP, SMT, BLC	Inner Surf/Near Super Struc
219	2.44	45	6.58	V	X	DSP, SMT, BLC	Inner Surf/Middle of Struc
220	2.44	45	6.58	V	Y	DSP, SMT, BLC	Inner Surf/Middle of Struc
221	2.44	90	6.58	V	X	DSP, SMT, BLC	Inner Surf/Middle of Struc
222	2.44	90	6.58	V	Y	DSP, SMT, BLC	Inner Surf/Middle of Struc

## DICE THROW, SHELTER C DATA CORRECTIONS (cont'd)

## COORDINATES

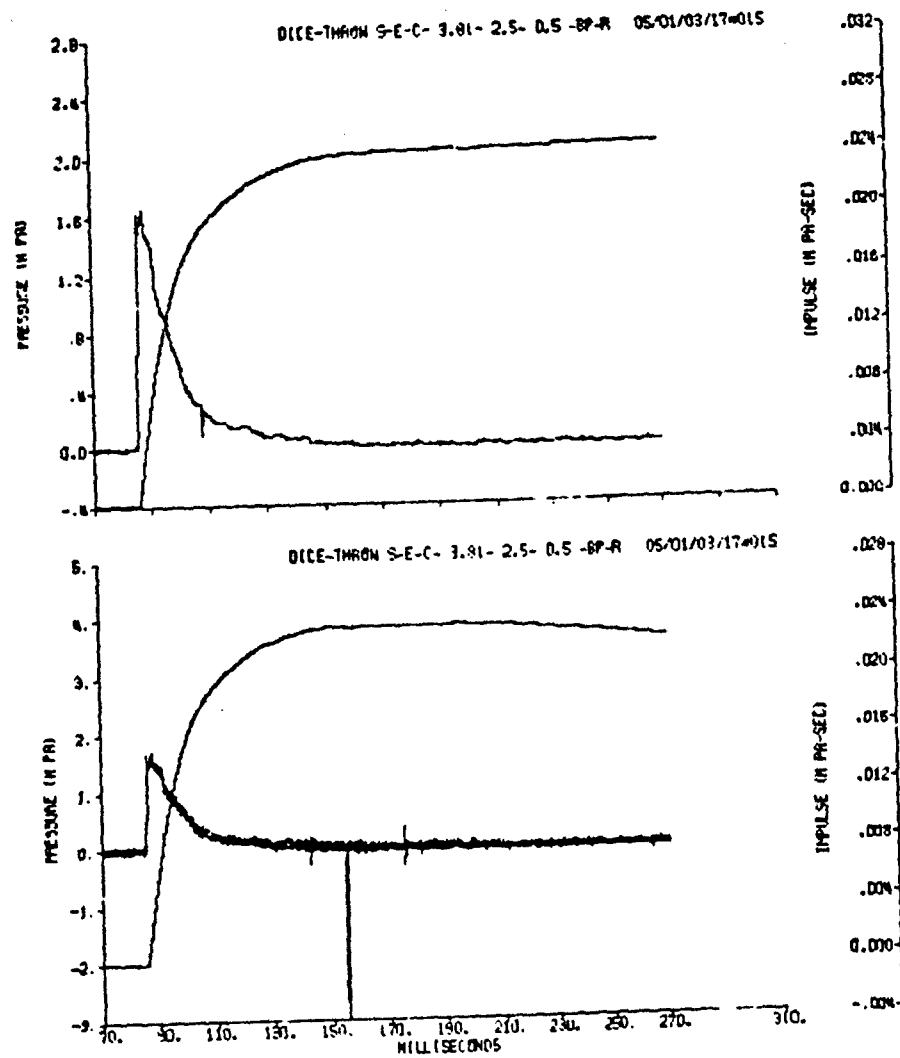
MEAS. NO.	R METERS	θ DEGREES	Z METERS	MEAS. TYPE	SENS. AXIS	DATA CORRECTIONS	GENERAL LOCATIONS
223	2.44	135	6.58	V	X	DSP, SMT	Inner Surf/Middle of Struc
224	2.44	135	6.58	V	Y	DSP, SMT	Inner Surf/Middle of Struc
236	2.44	2.5	6.58	V	X	DSP, SMT, BLC	Inner Surf/Middle of Struc
237	2.44	2.5	6.58	V	Y	DSP, SMT, BLC	Inner Surf/Middle of Struc
238	2.44	177.5	6.58	V	X	DSP, SMT	Inner Surf/Middle of Struc
239	2.44	177.5	6.53	V	Y	DSP, SMT, BLC	Inner Surf/Middle of Struc
421	2.68	30	3.50	SE	R	DSP, SMT	Inner Reinf/Near Super Struc
422	2.68	60	3.50	SE	R	DSP, SMT	Inner Reinf/Near Super Struc
423	2.68	90	3.50	SE	R	DSP, SMT	Inner Reinf/Near Super Struc
424	2.58	120	3.50	SE	R	DSP	Inner Reinf/Near Super Struc
425	2.68	150	3.50	SE	R	DSP, SMT	Inner Reinf/Near Super Struc
426	2.46	30	3.50	SE	R	DSP	Outer Reinf/Near Super Struc
427	2.46	60	3.50	SE	R	DSP, SMT	Outer Reinf/Near Super Struc
428	2.46	90	3.50	SE	R	DSP, SMT	Outer Reinf/Near Super Struc
429	2.46	120	3.50	SE	R	DSP, SMT	Outer Reinf/Near Super Struc
430	2.46	150	3.50	SE	R	DSP, SMT	Outer Reinf/Near Super Struc
431	2.68	30	6.58	SE	R	DSP, SMT, FIL	Outer Reinf/Near Super Struc
432	2.68	60	6.58	SE	R	DSP, SMT	Inner Reinf/Middle of Struc
433	2.68	90	6.58	SE	R	DSP, SMT	Inner Reinf/Middle of Struc
434	2.68	120	6.58	SE	R	DSP, SMT	Inner Reinf/Middle of Struc
435	2.68	150	6.58	SE	R	DSP, SMT	Inner Reinf/Middle of Struc
436	2.46	30	6.58	SE	R	DSP, SMT	Outer Reinf/Middle of Struc
437	2.46	60	6.58	SE	R	DSP, SMT, FIL	Outer Reinf/Middle of Struc
438	2.46	90	6.58	SE	R	DSP, SMT	Outer Reinf/Middle of Struc
439	2.46	120	6.58	SE	R	DSP, SMT	Outer Reinf/Middle of Struc
440	2.46	150	6.58	SE	R	DSP, SMT	Outer Reinf/Middle of Struc
441	2.74	30	3.50	SE	R	DSP, SMT	Inner Reinf, Upgrade/Near Sup Str
442	2.74	60	3.50	SE	R	DSP	Inner Reinf, Upgrade/Near Sup Str



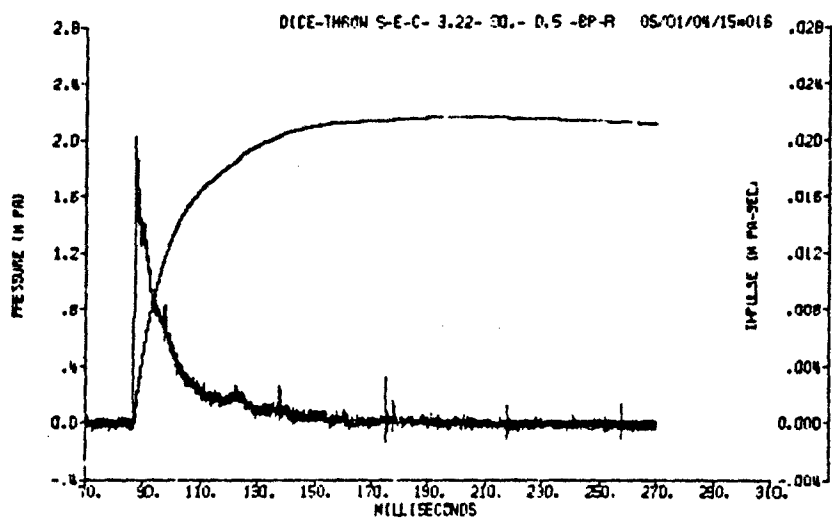
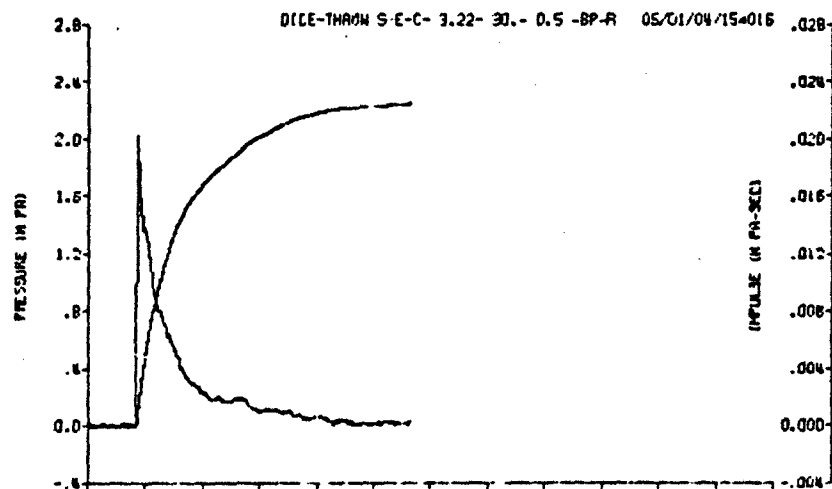
## DICE THROW, SHELTER C DATA CORRECTIONS (cont'd)

COORDINATES							
MEAS. NO.	R METERS	θ DEGREES	Z METERS	MEAS. TYPE	SENS. AXIS	DATA CORRECTIONS	GENERAL LOCATIONS
443	2.74	90	3.50	SE	R	DSP,SMT	Inner Reinf, Upgrade/Near Su
444	2.74	120	3.50	SE	R	DSP,SMT	Inner Reinf, Upgrade/Near Su
445	2.74	150	3.50	SE	R	DSP,SMT	Inner Reinf, Upgrade/Near Su
446	3.19	30	3.50	SE	R	DSP,SMT	Outer Reinf Upgrade/Near Sup
447	3.19	60	3.50	SE	R	DSP,SMT	Outer Reinf Upgrade/Near Sup
448	3.19	90	3.50	SE	R	DSP,SMT	Outer Reinf Upgrade/Near Sup
449	3.19	120	3.50	SE	R	DSP,SMT	Outer Reinf Upgrade/Near Sup
450	3.19	150	3.50	SE	R	DSP,SMT	Outer Reinf Upgrade/Near Sup
451	2.74	30	6.58	SE	R	DSP,SMT	Inner Reinf Upgrade/Middle o
452	2.74	60	6.58	SE	R	DSP,SMT	Inner Reinf Upgrade/Middle o
453	2.74	90	6.58	SE	R	DSP,SMT	Inner Reinf Upgrade/Middle o
454	2.74	120	6.58	SE	R	DSP,SMT	Inner Reinf Upgrade/Middle o
455	2.74	150	6.58	SE	R	DSP,SMT	Inner Reinf Upgrade/Middle o
456	3.19	30	6.58	SE	R	DSP,SMT	Outer Reinf Upgrade/Middle o
457	3.19	60	6.58	SE	R	DSP,SMT	Outer Reinf Upgrade/Middle o
458	3.19	90	6.58	SE	R	DSP,SMT	Outer Reinf Upgrade/Middle o
459	3.19	120	6.58	SE	R	DSP,SMT	Outer Reinf Upgrade/Middle o
460	3.19	150	6.58	SE	R	DSP,SMT	Outer Reinf Upgrade/Middle o

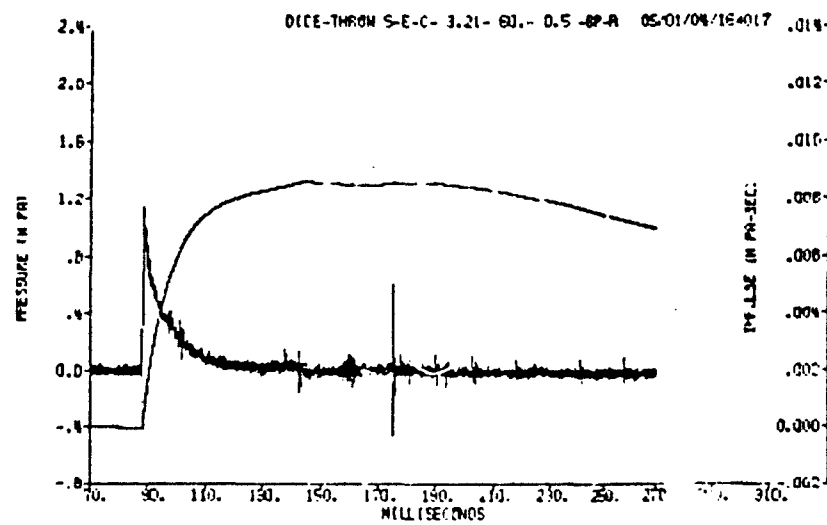
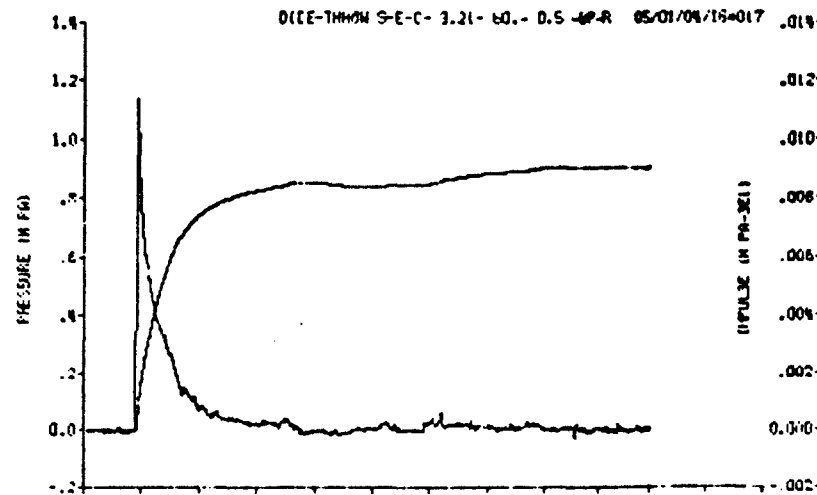
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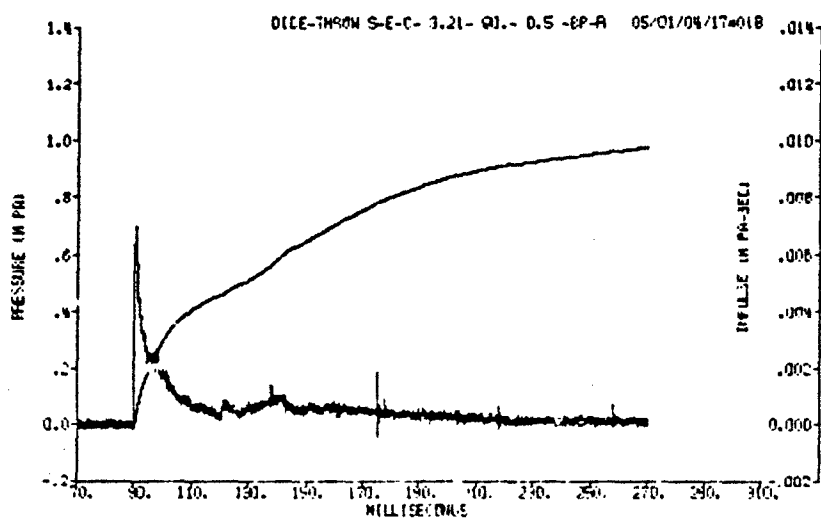
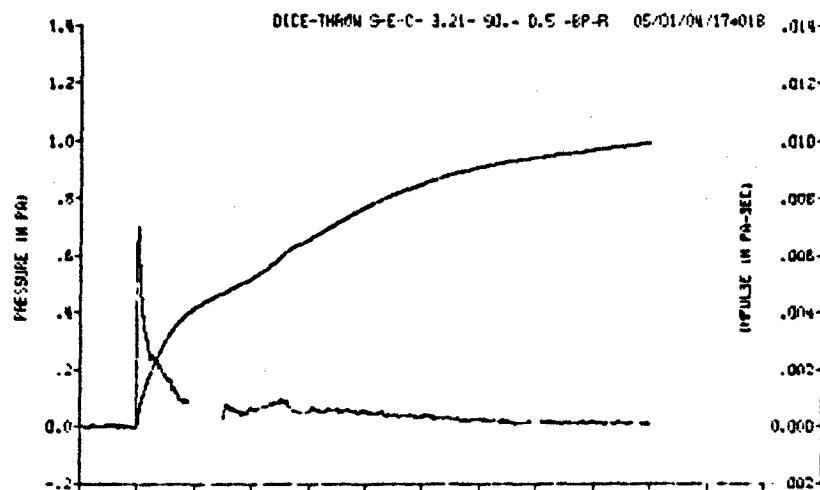
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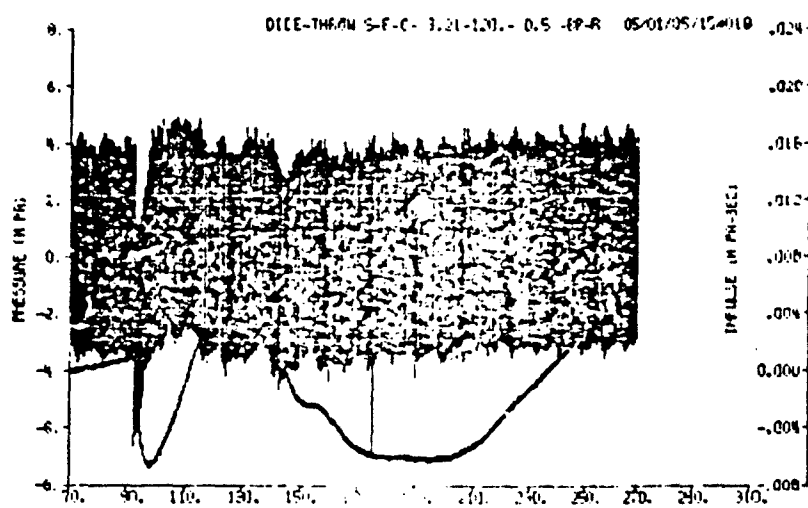
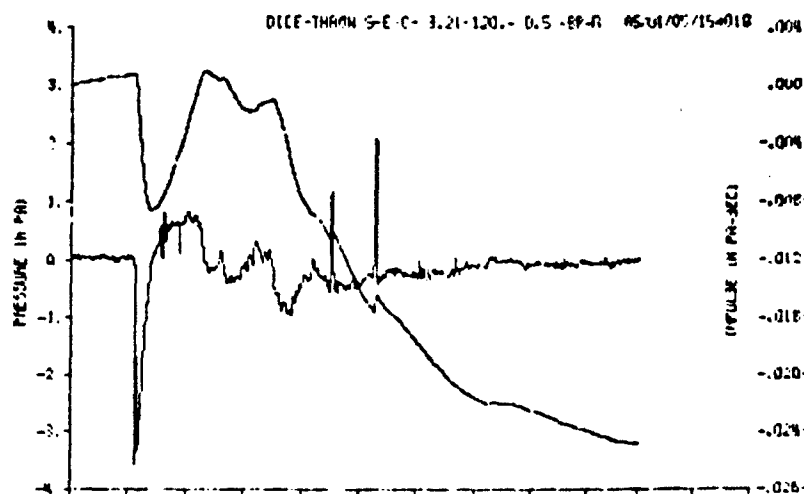
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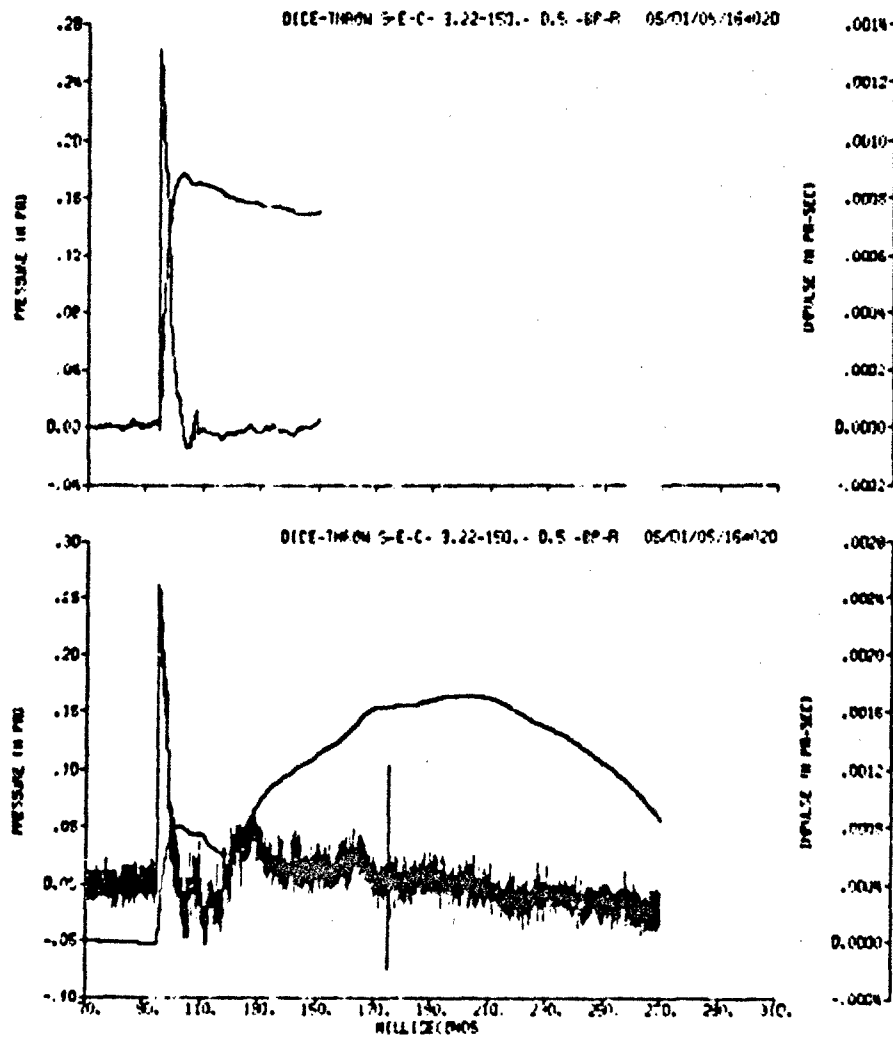
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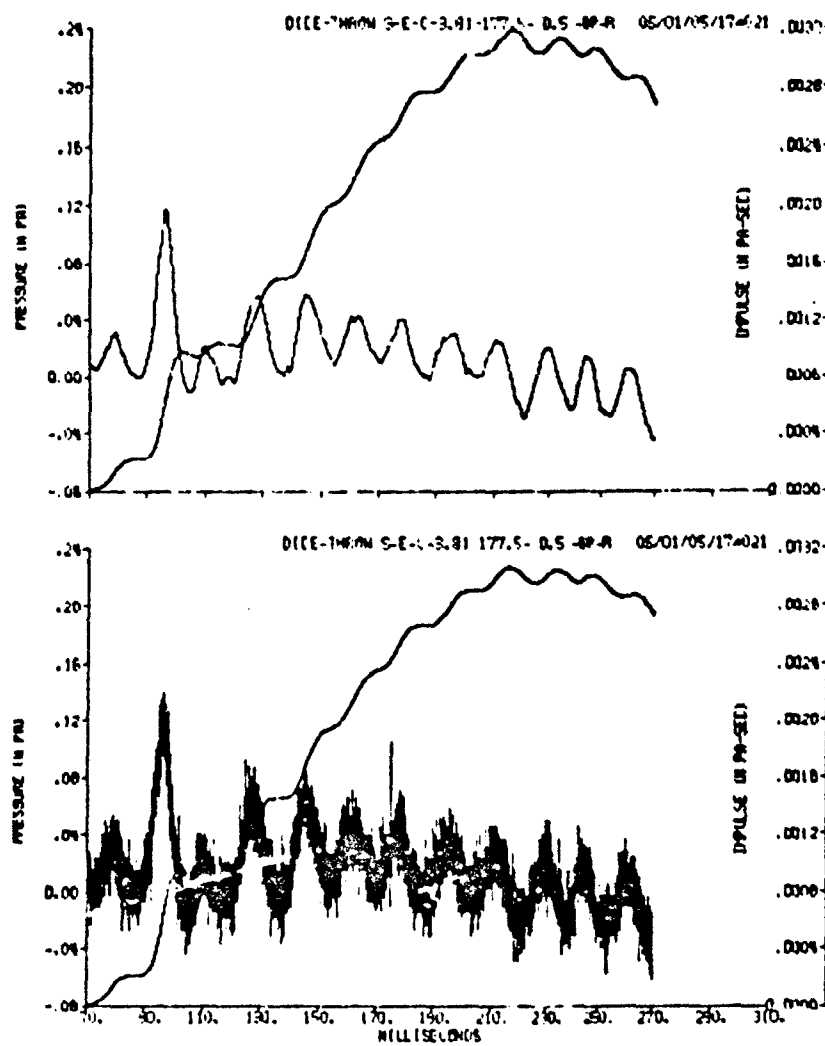
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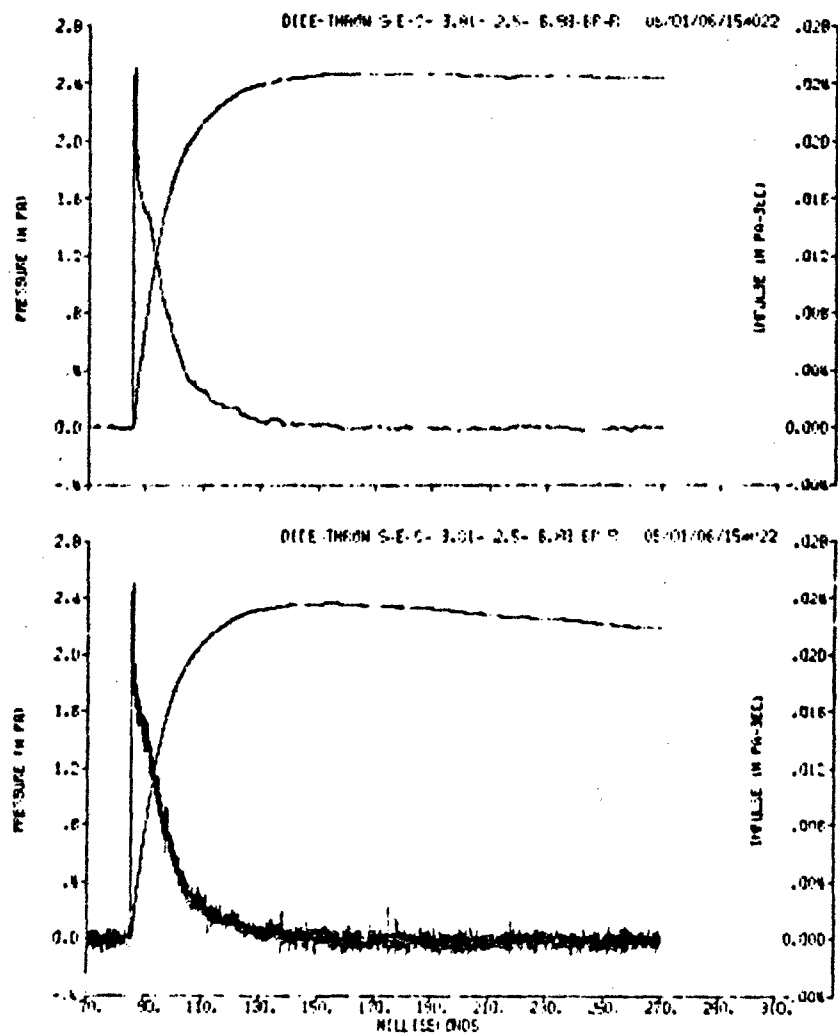


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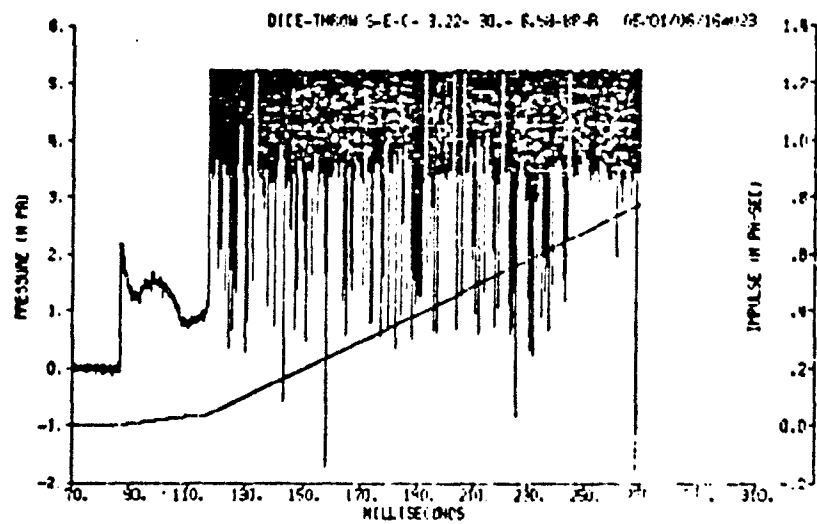
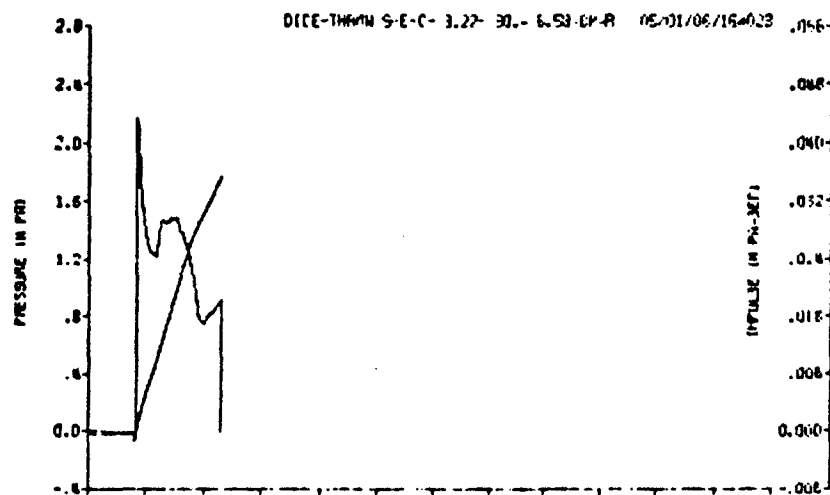




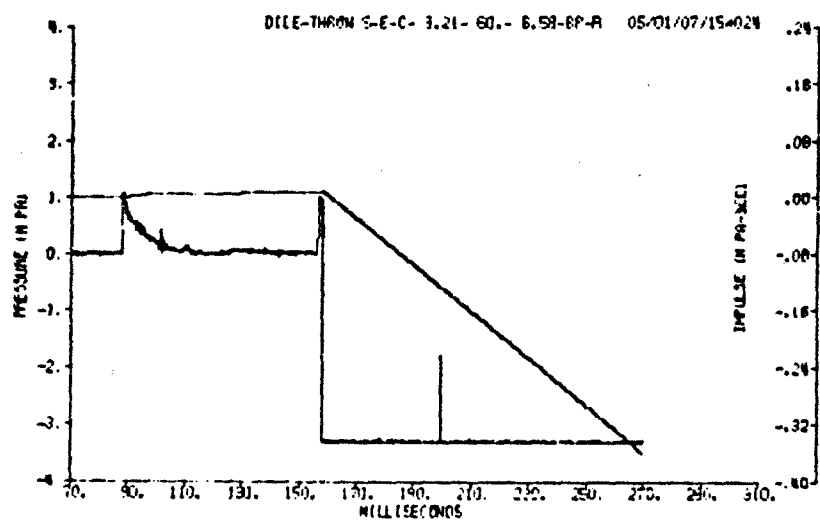
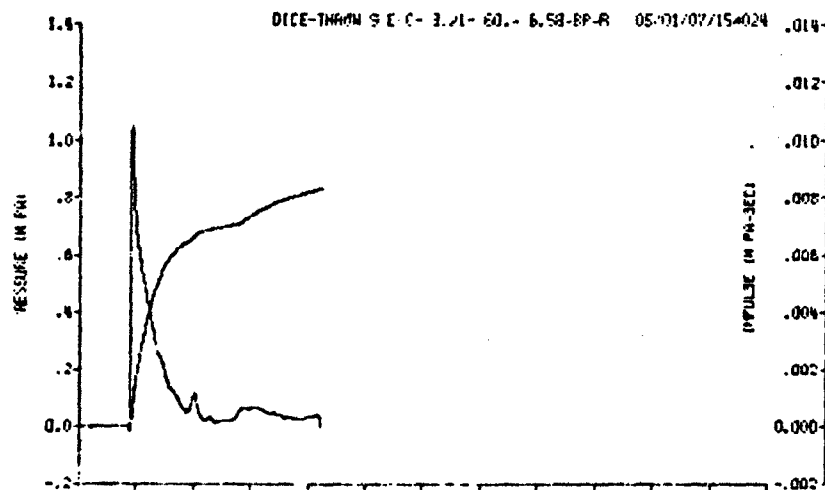
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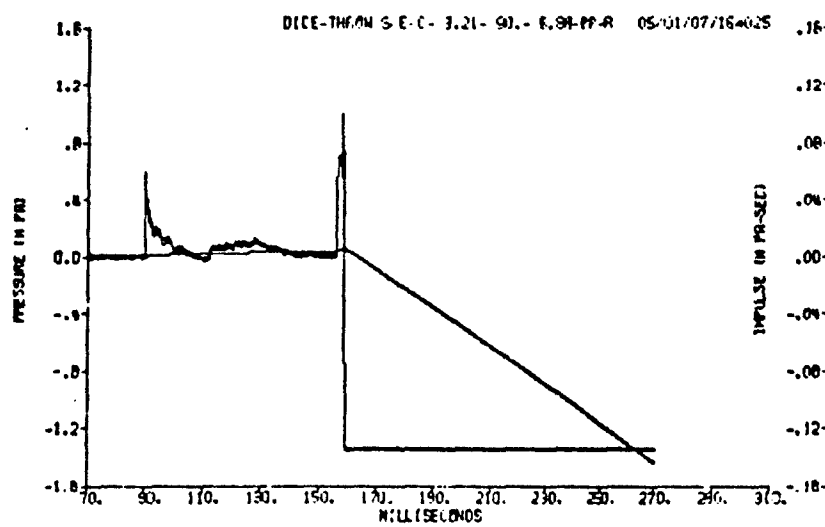
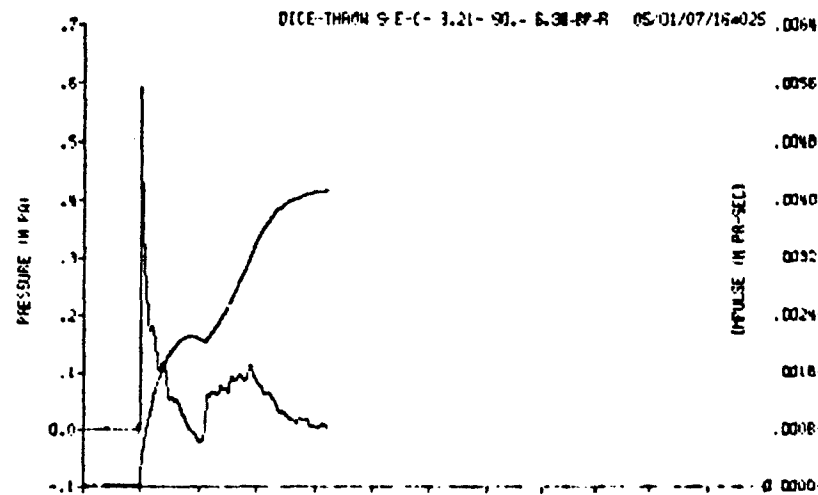
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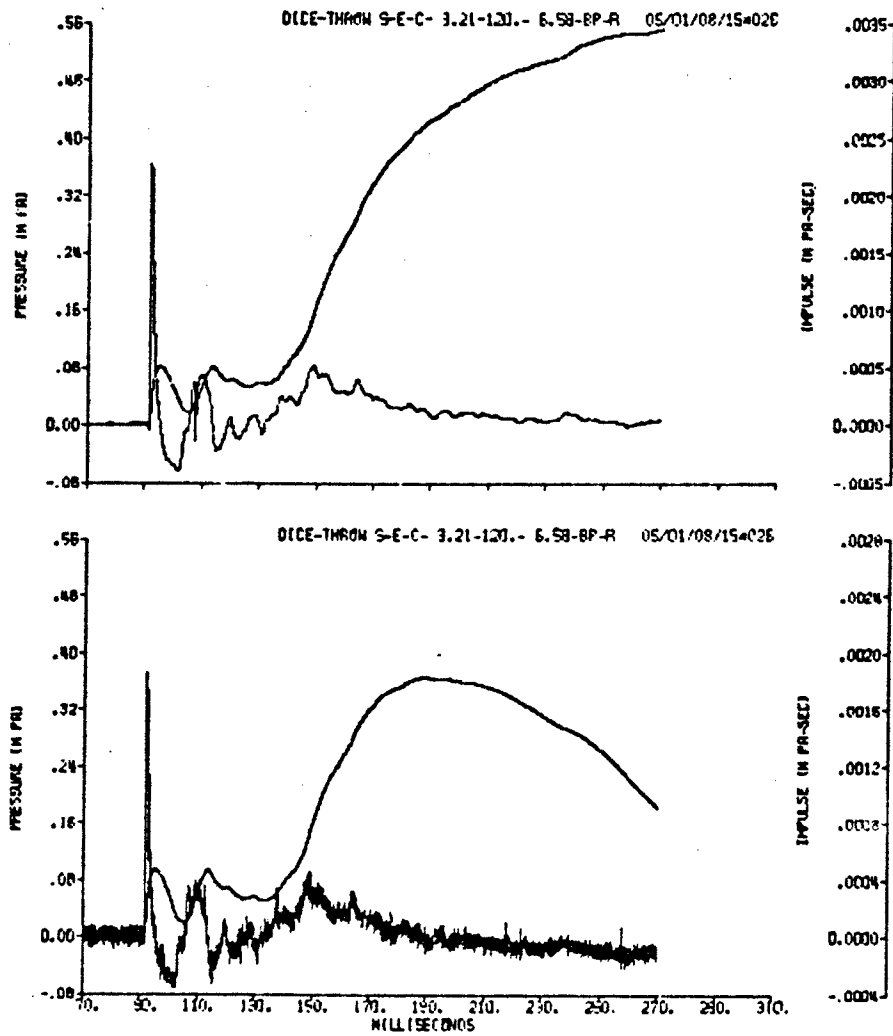
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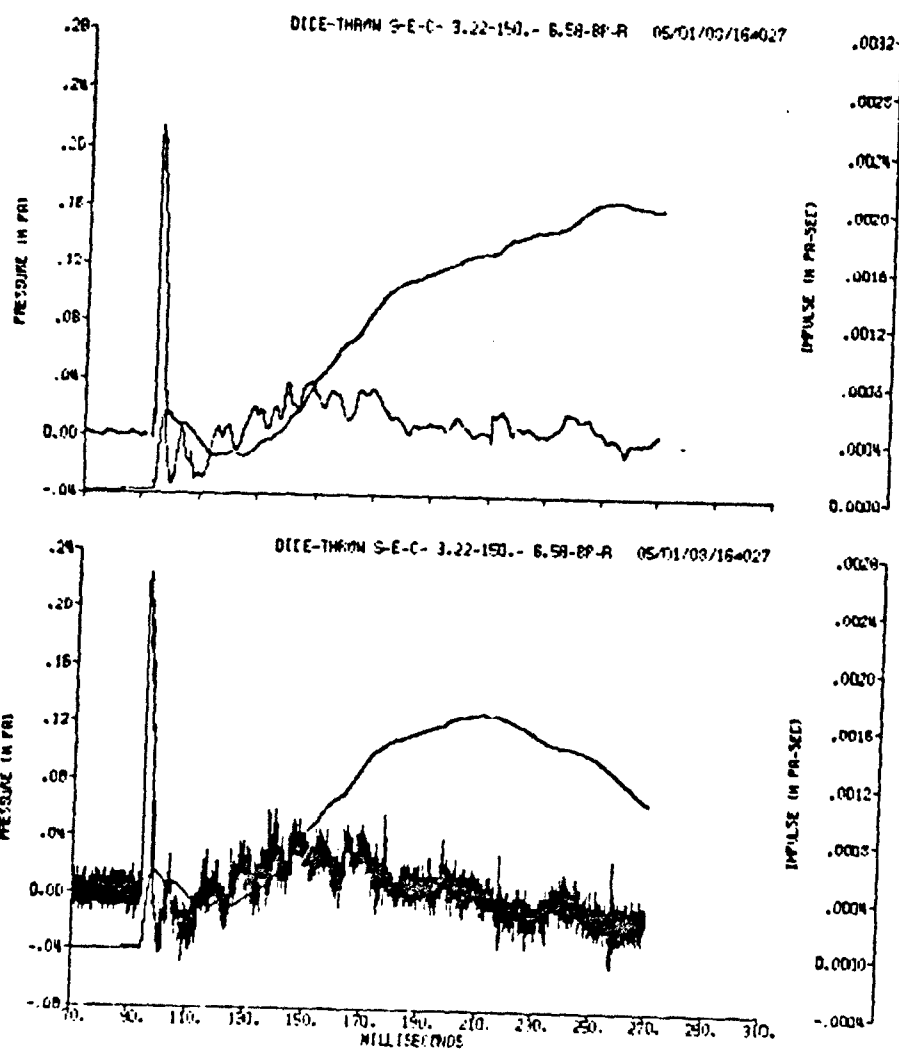
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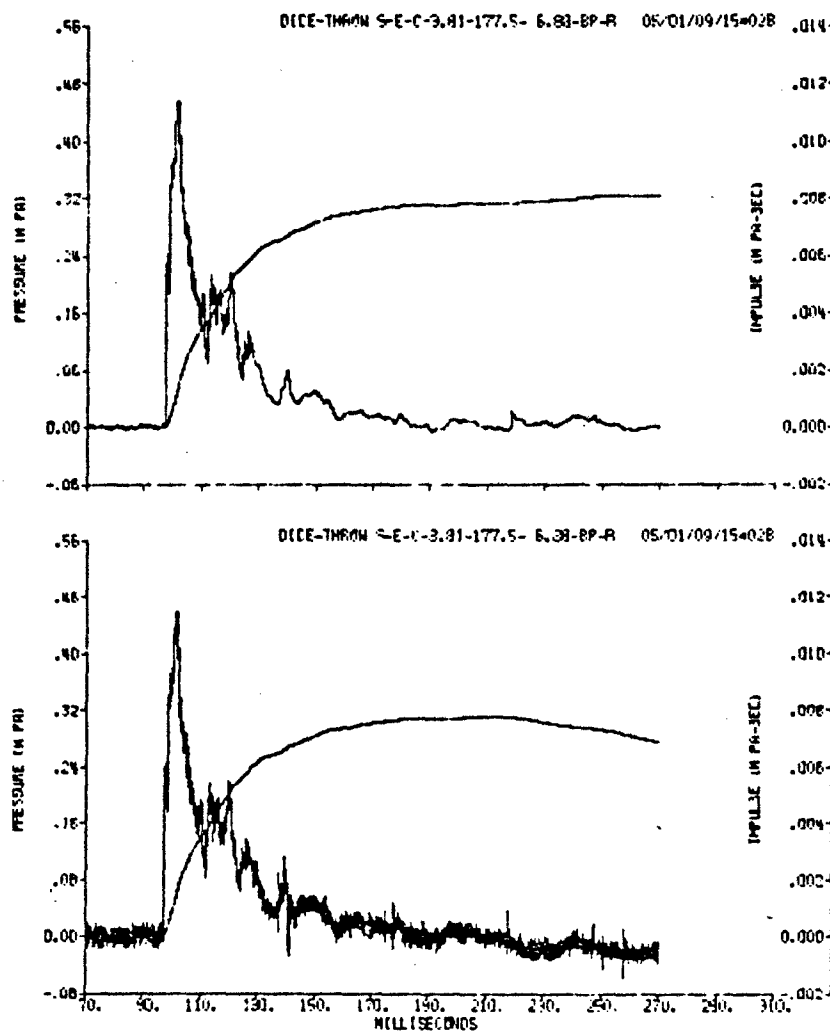
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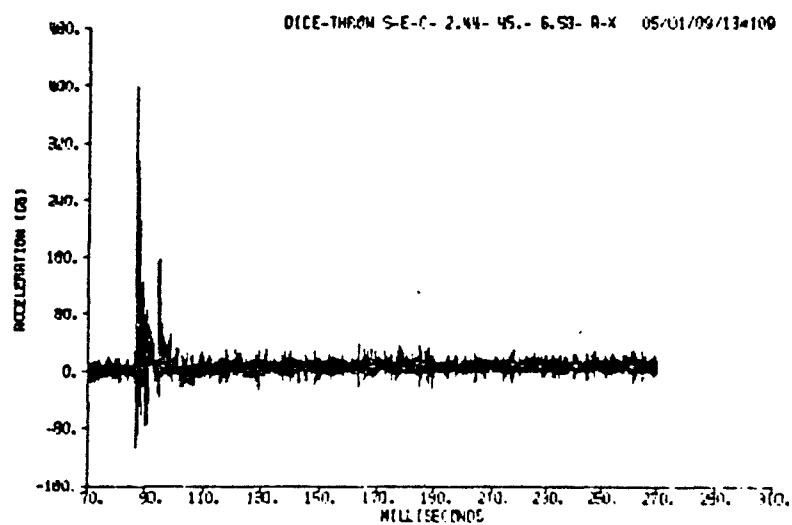
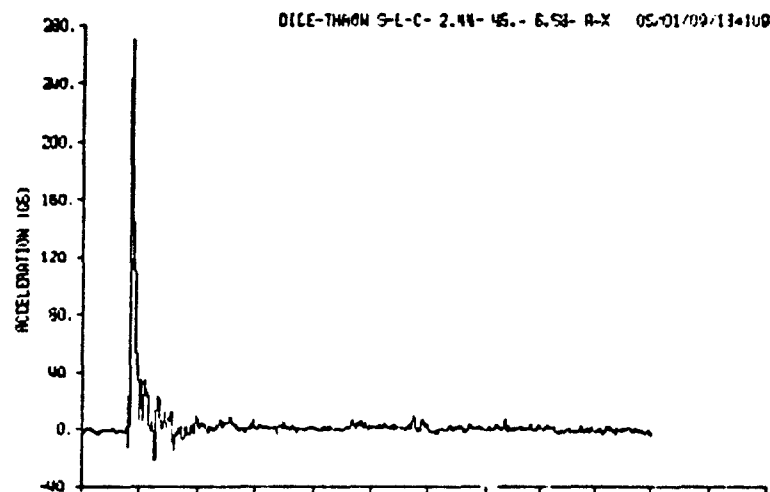
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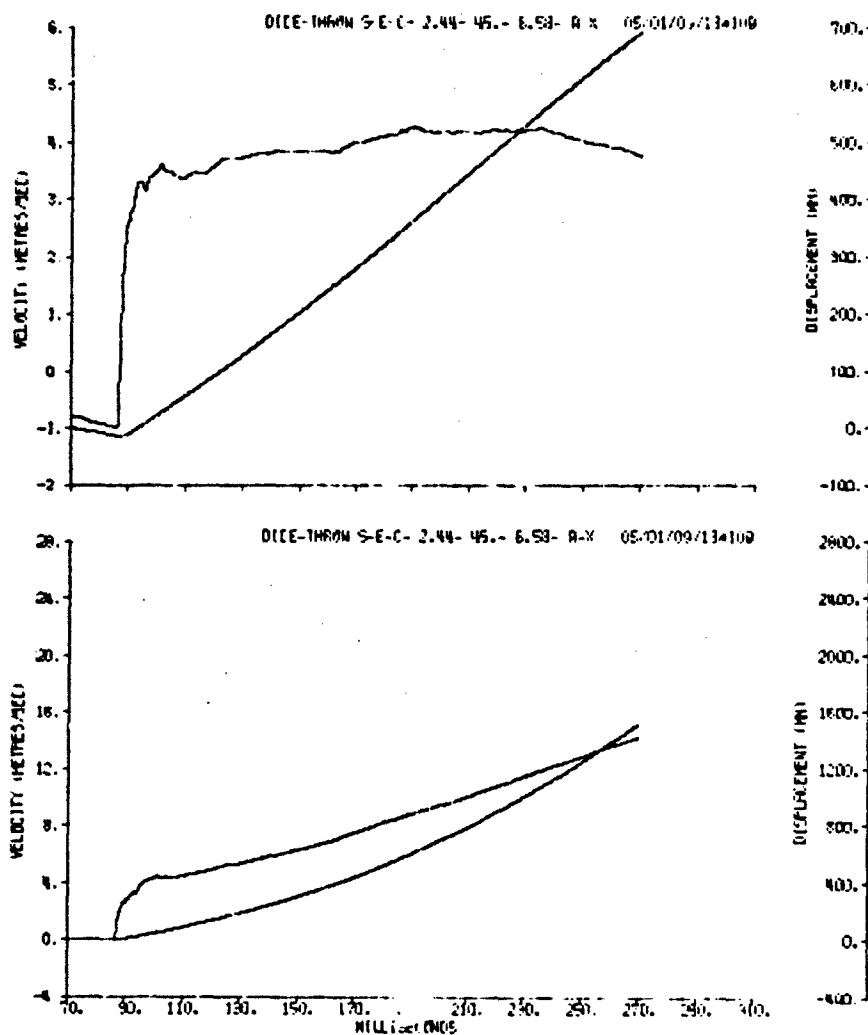
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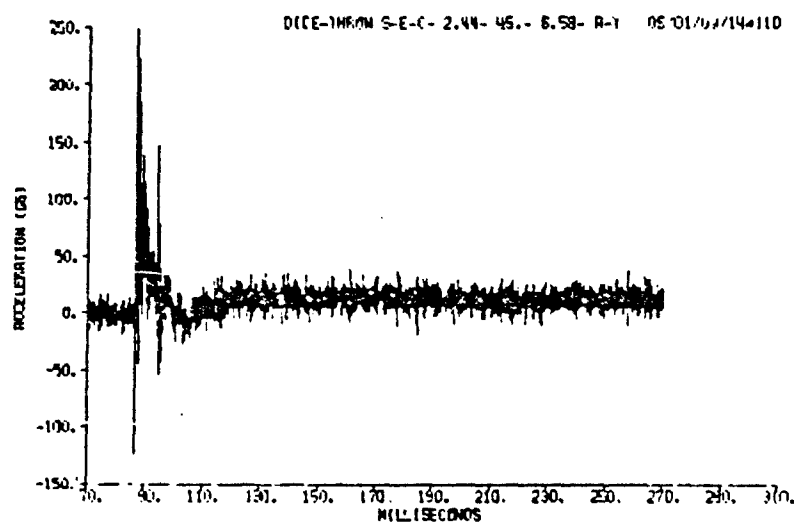
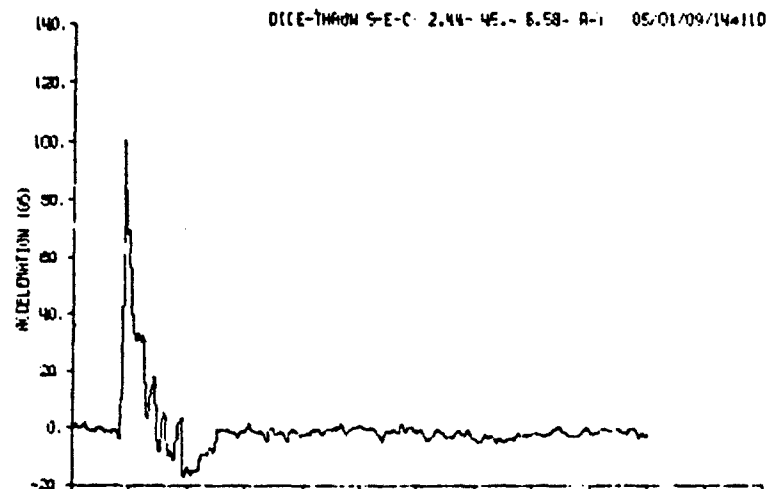
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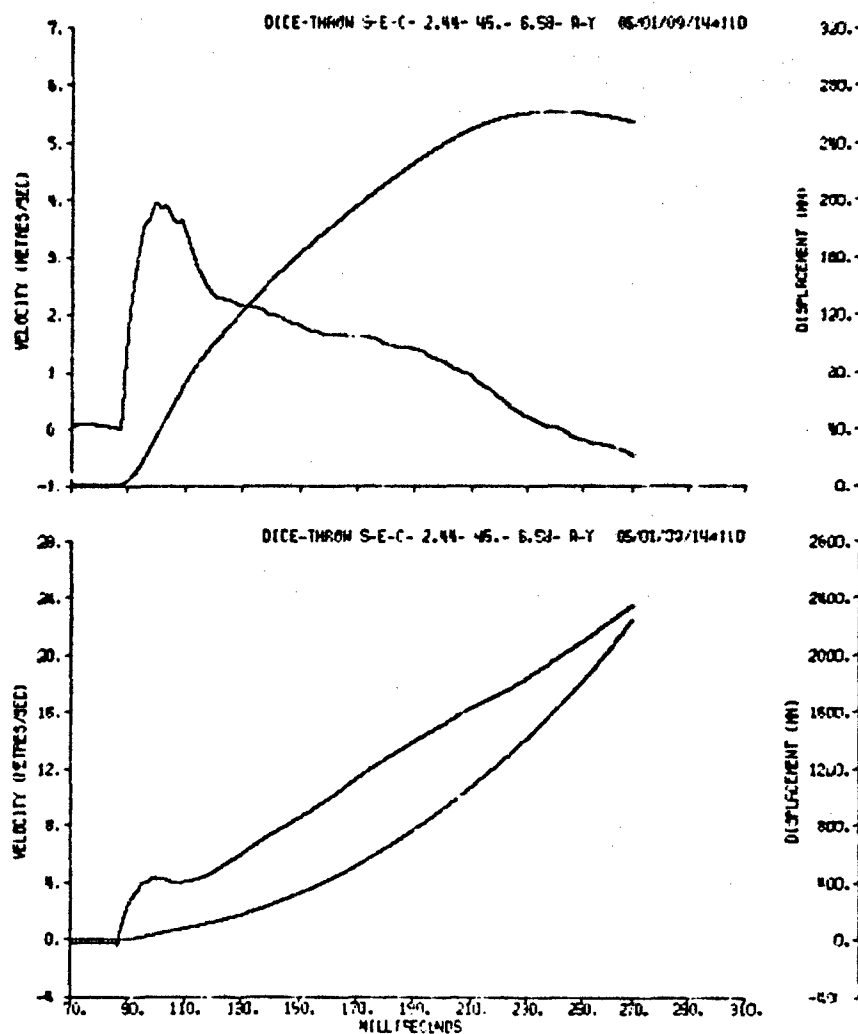




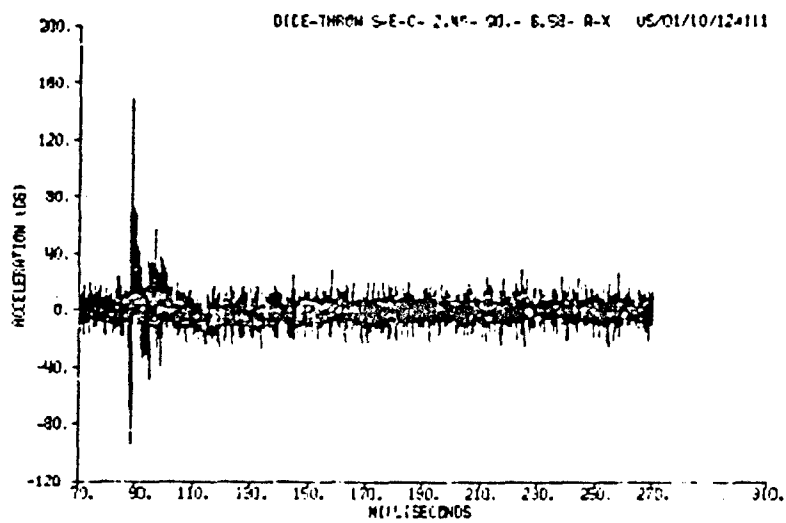
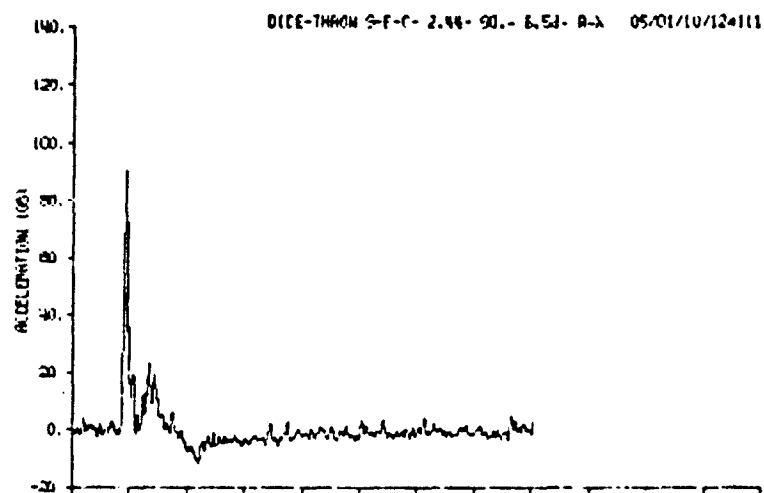
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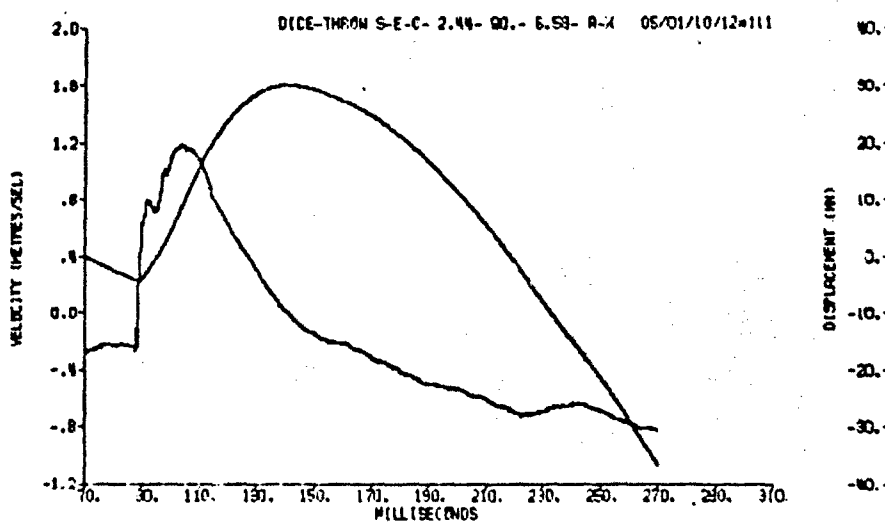
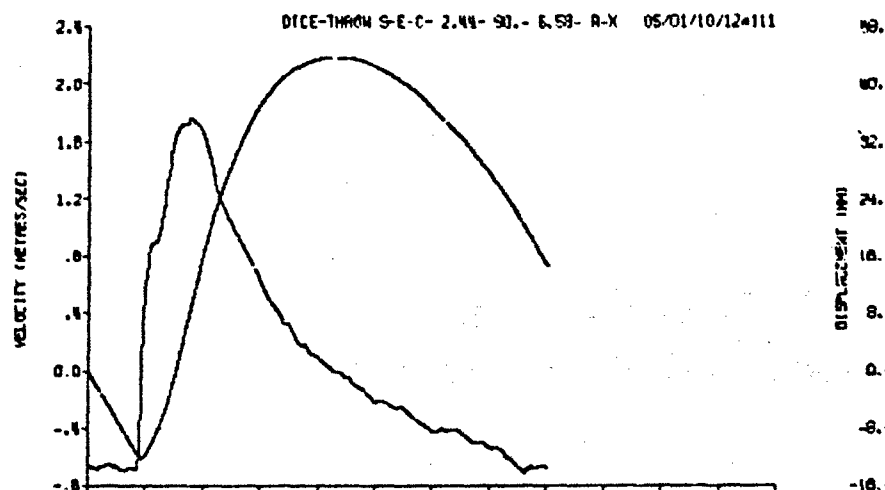
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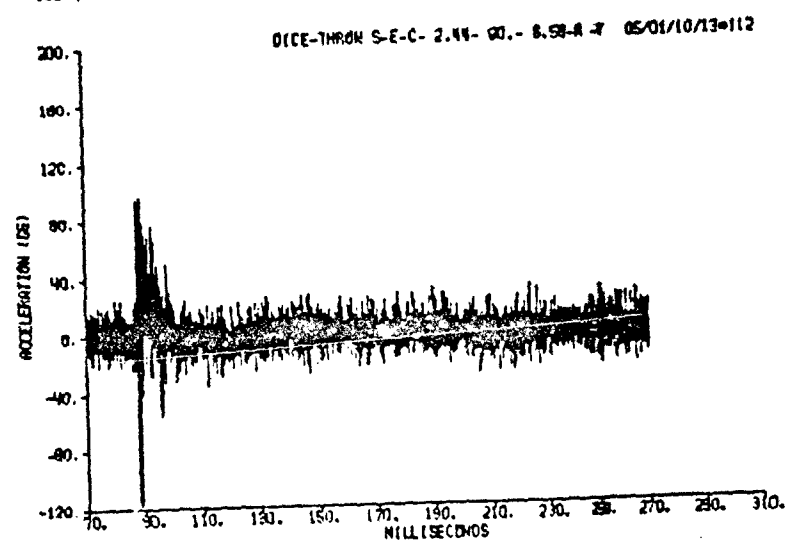
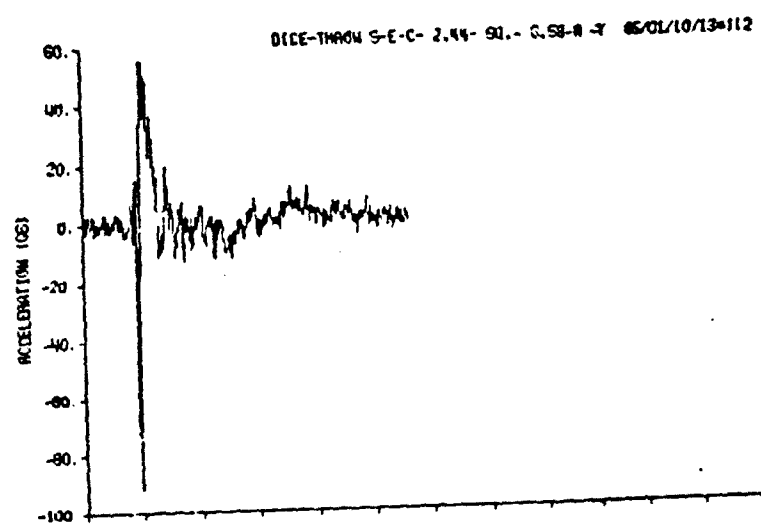
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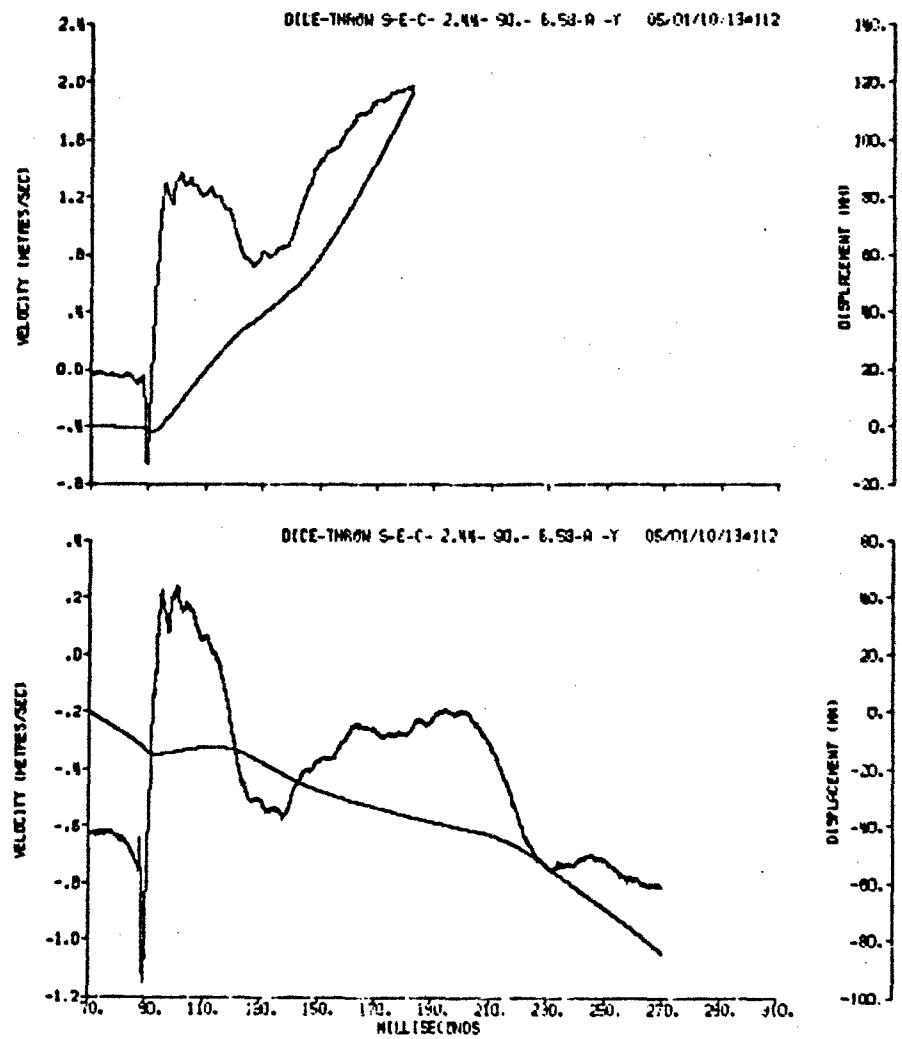
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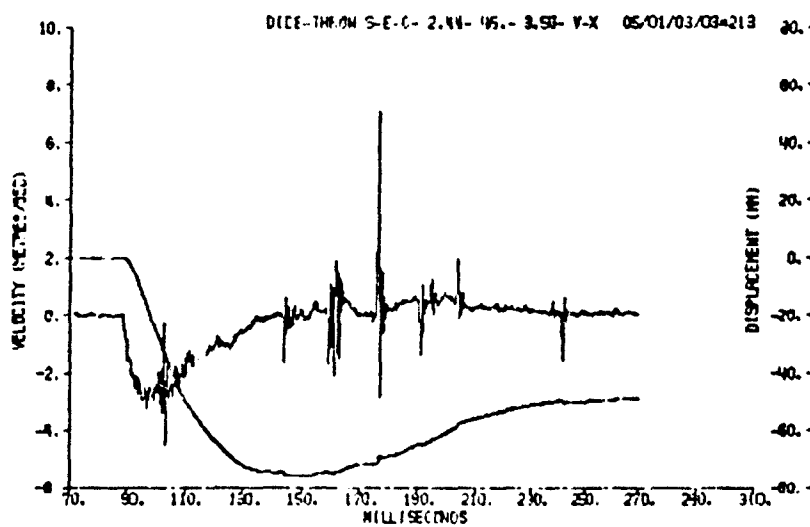
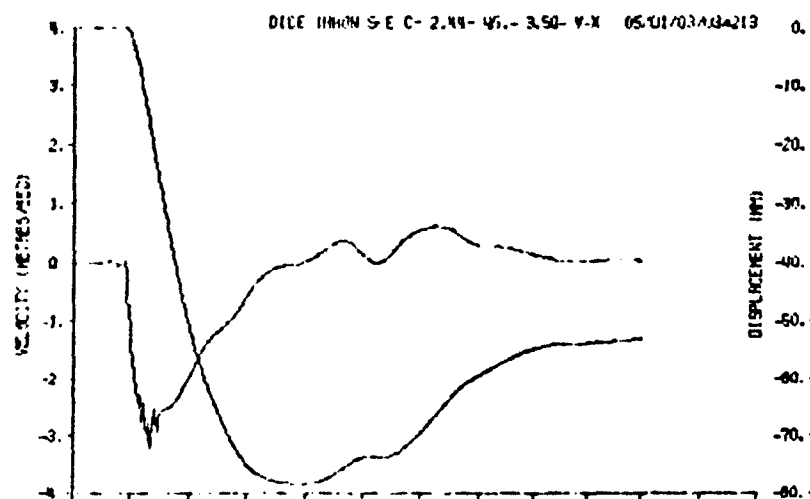
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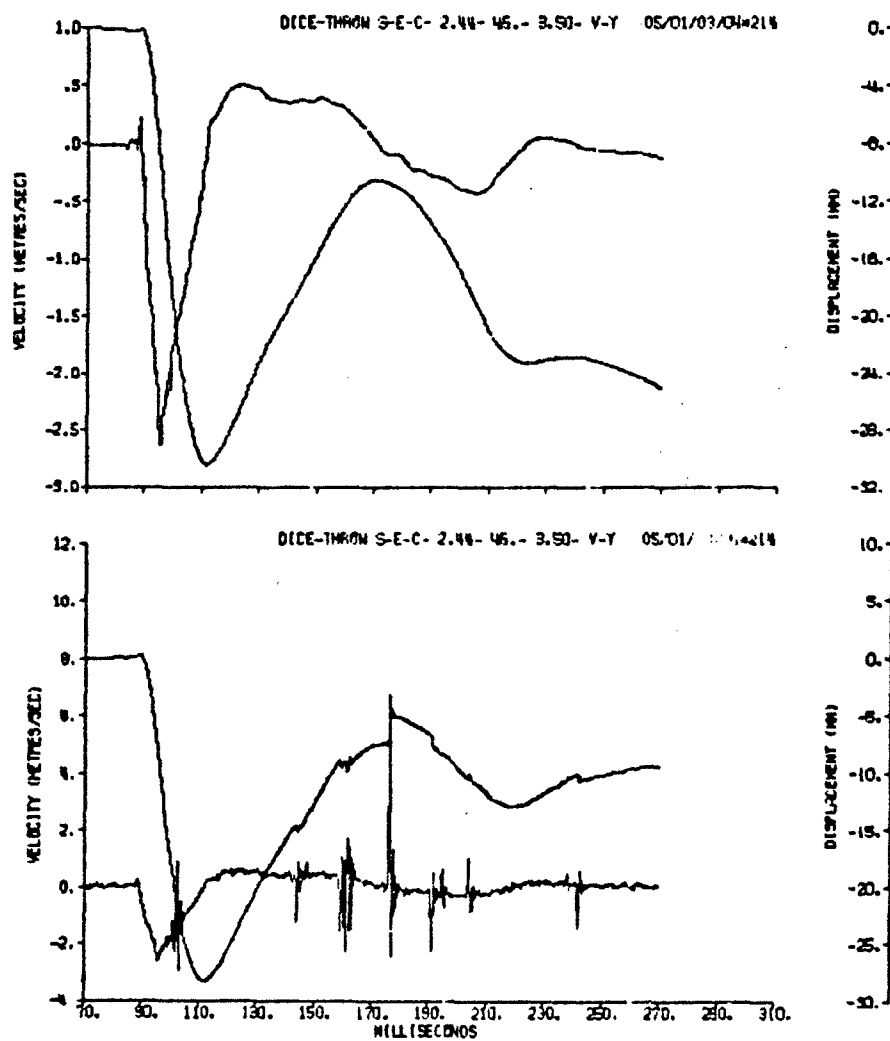


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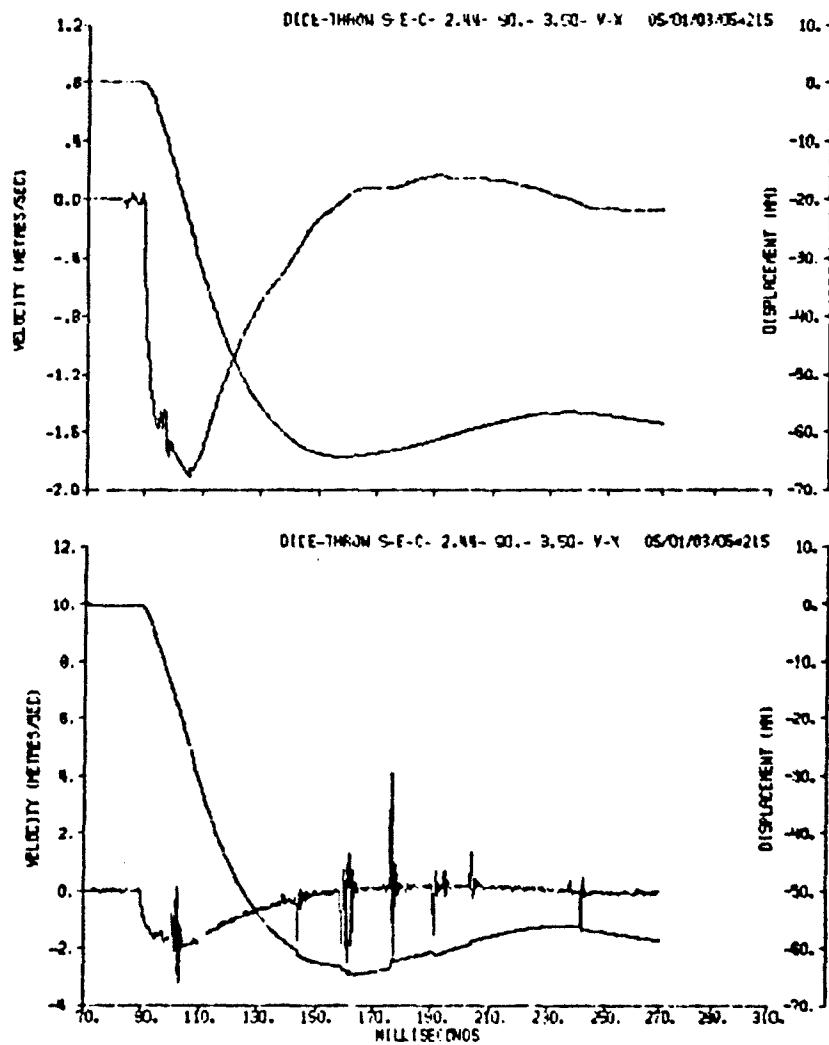


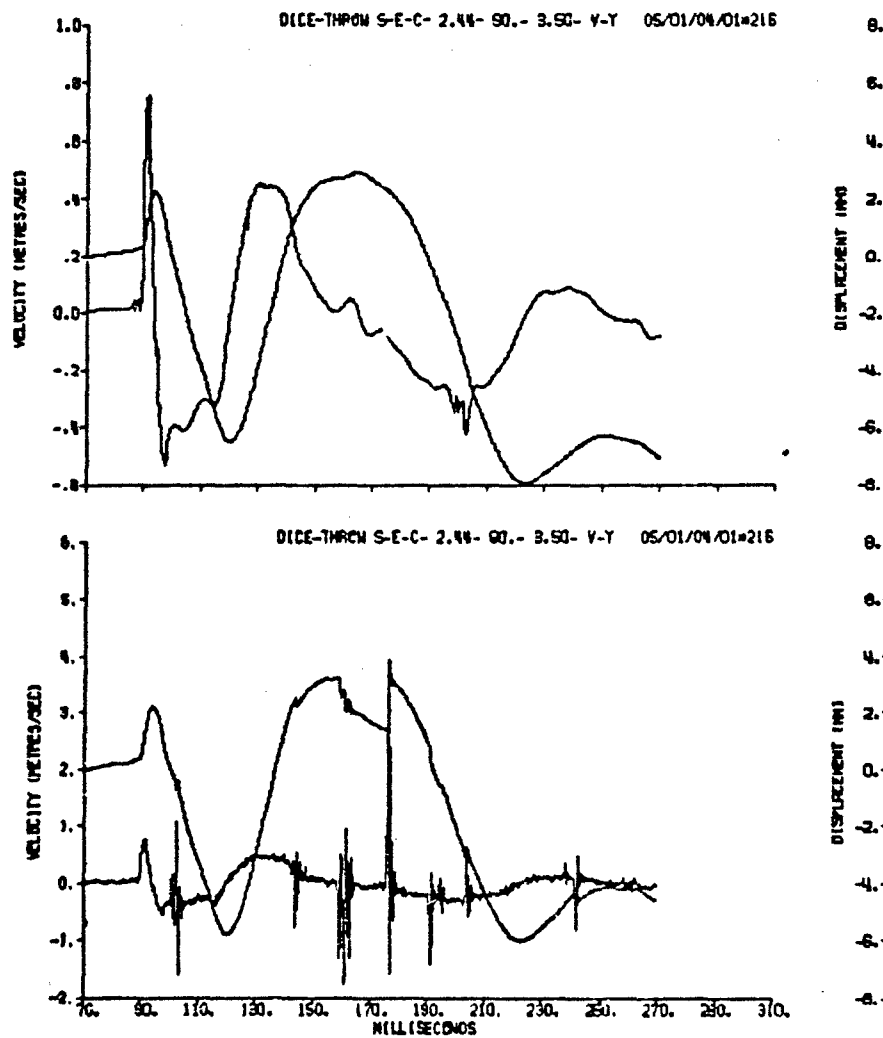


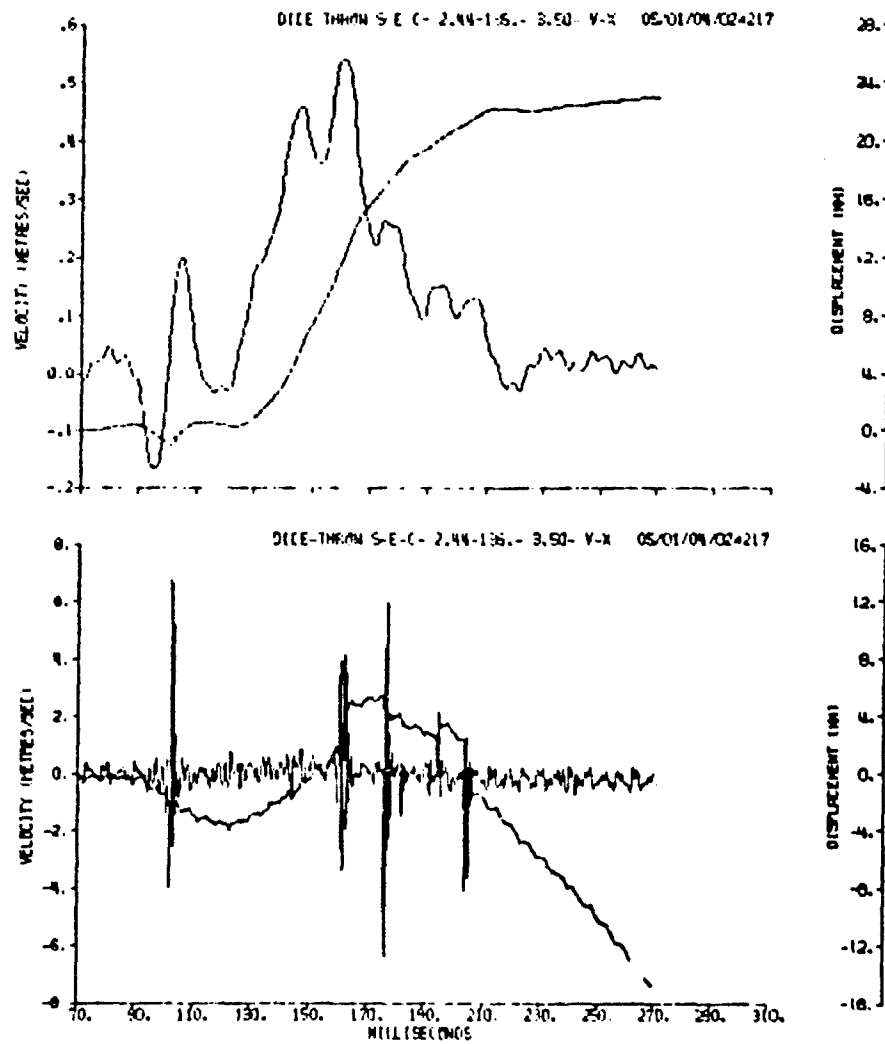
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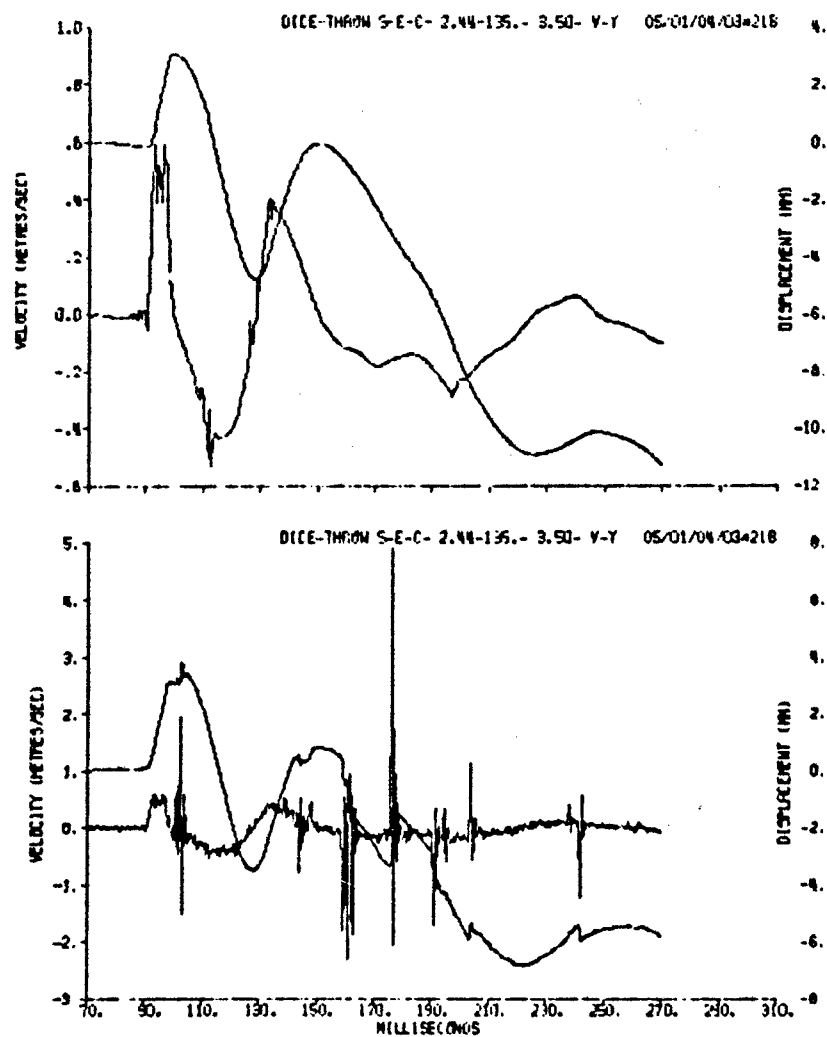


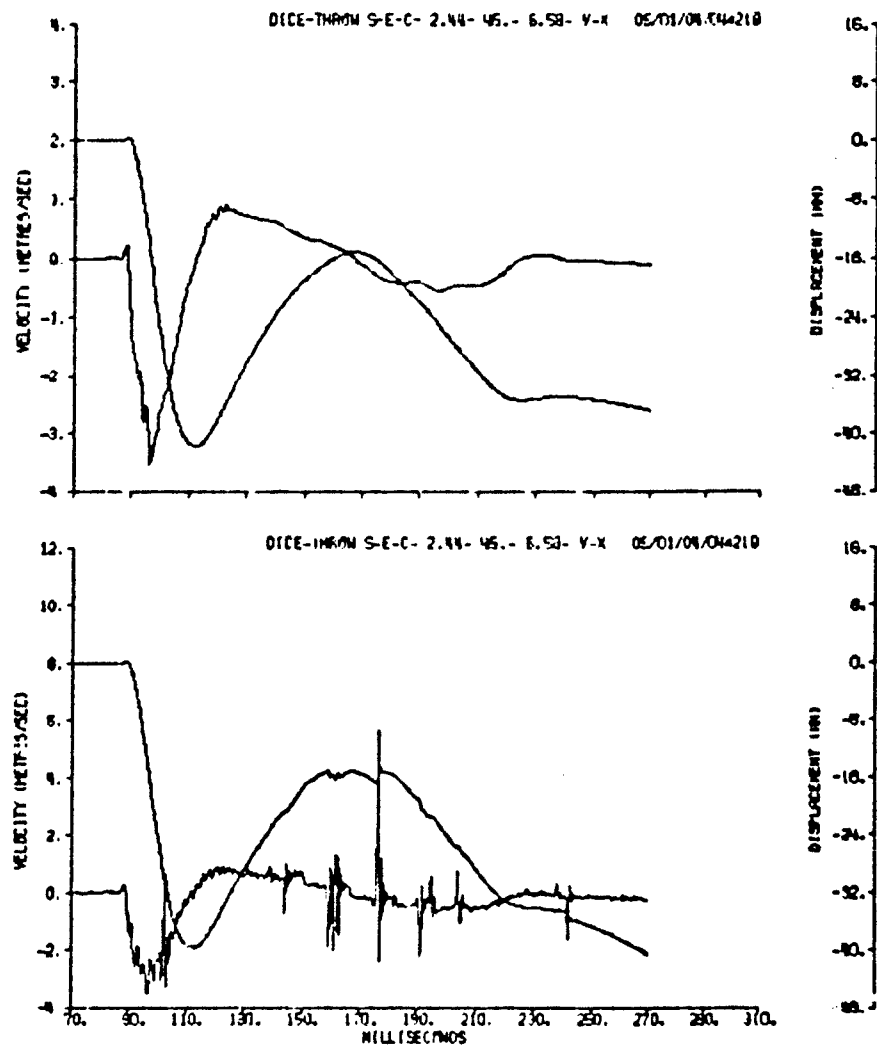
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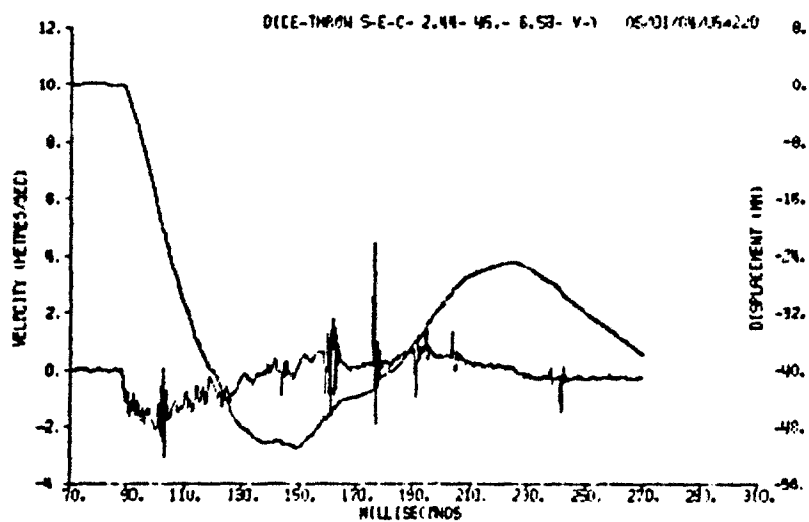
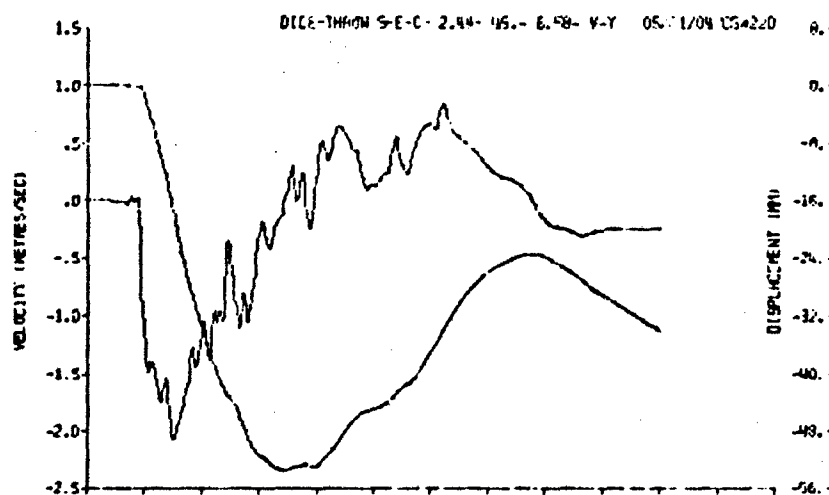


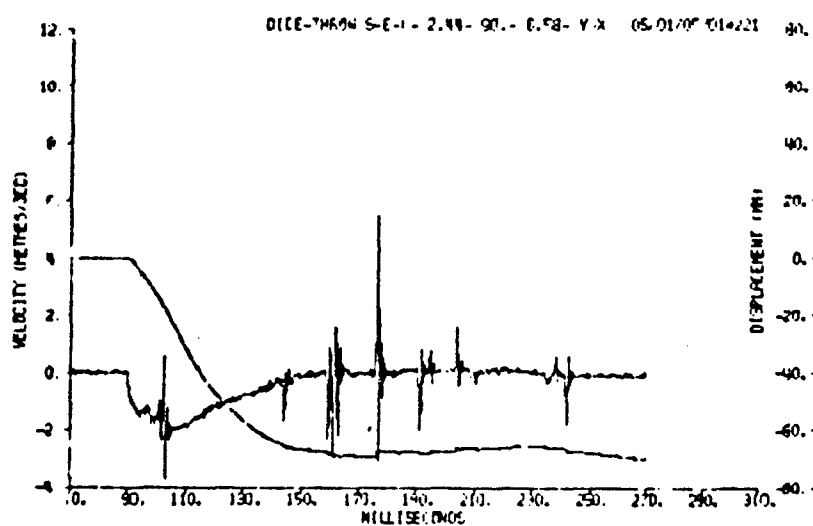
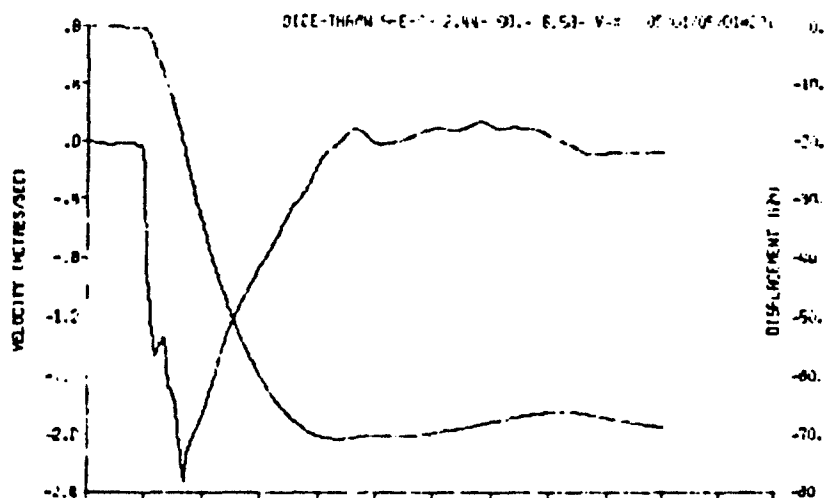






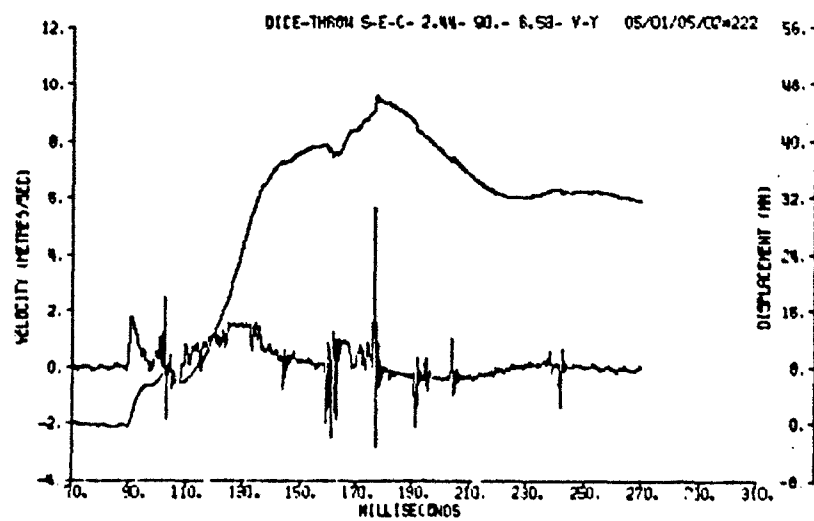
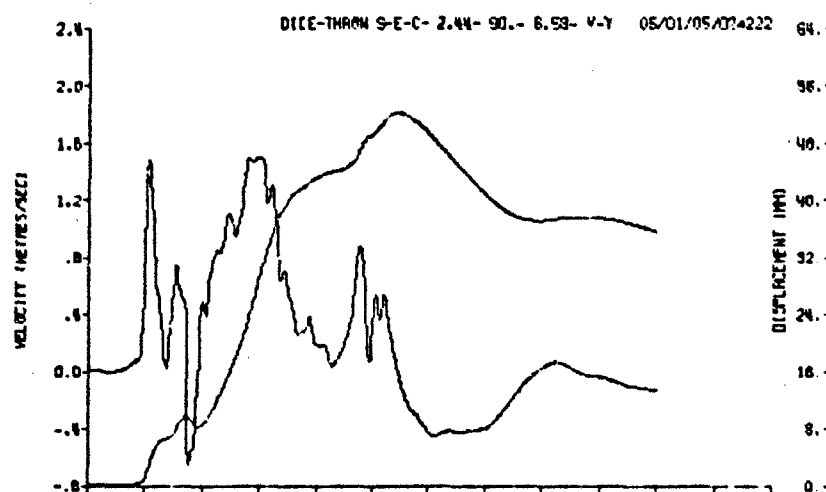




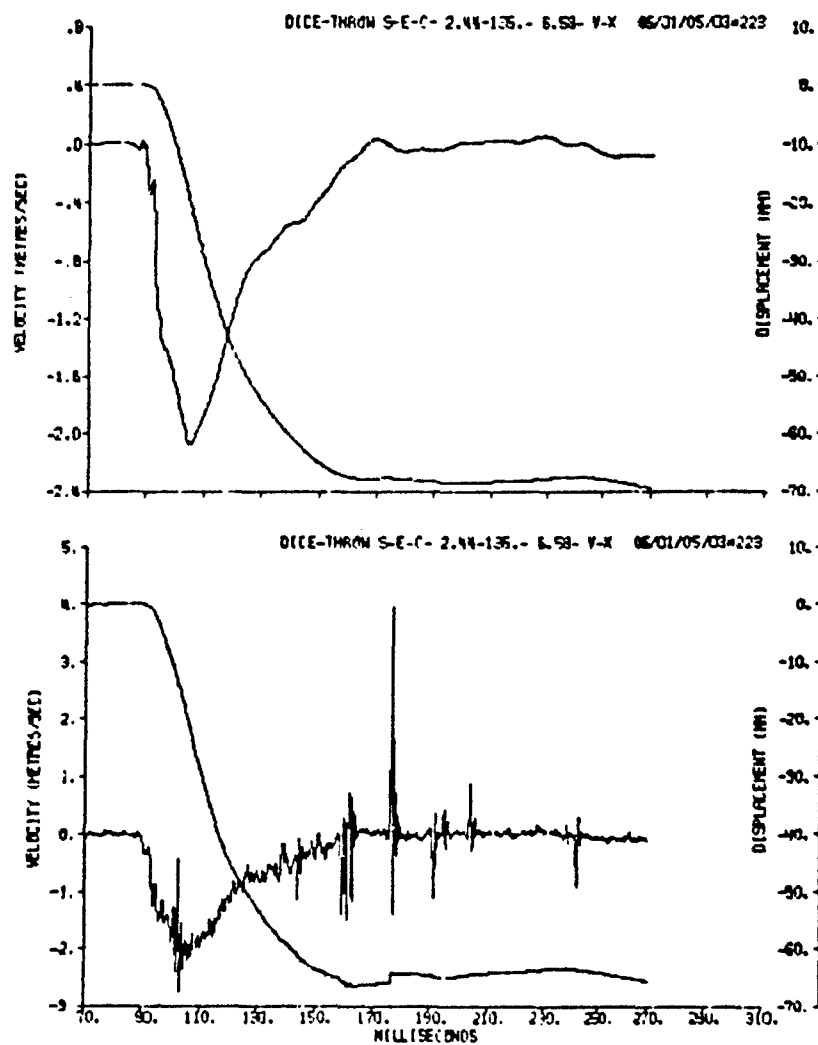




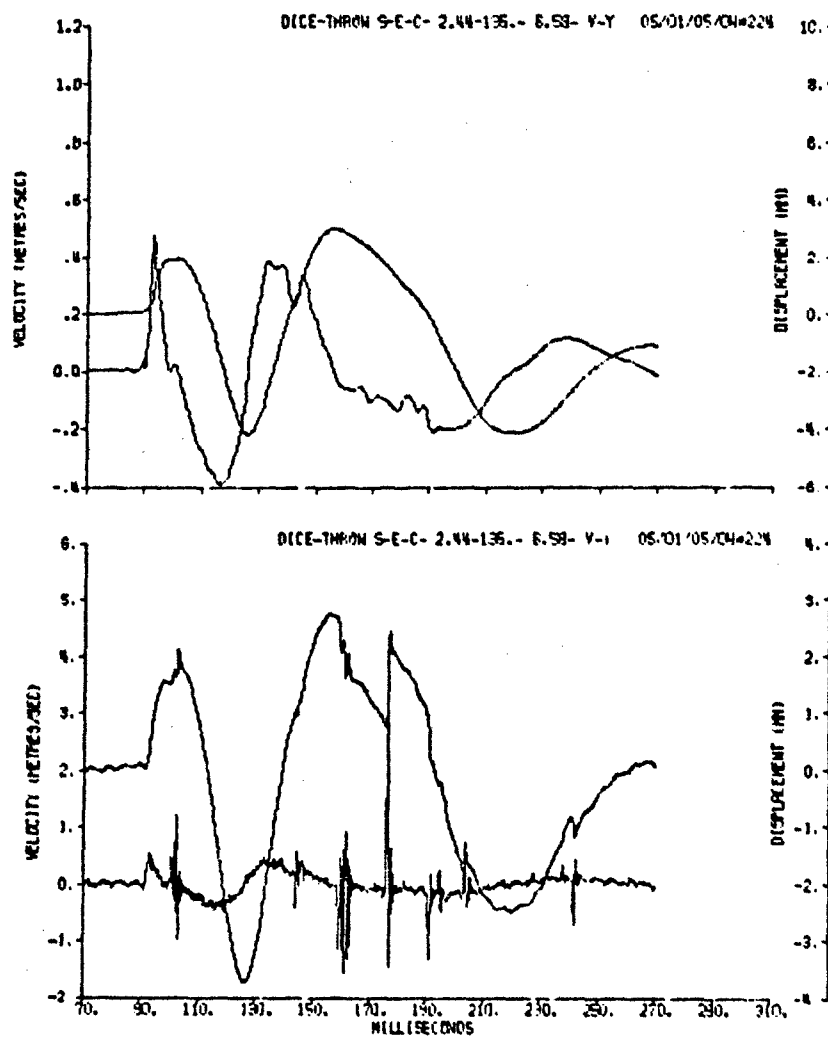
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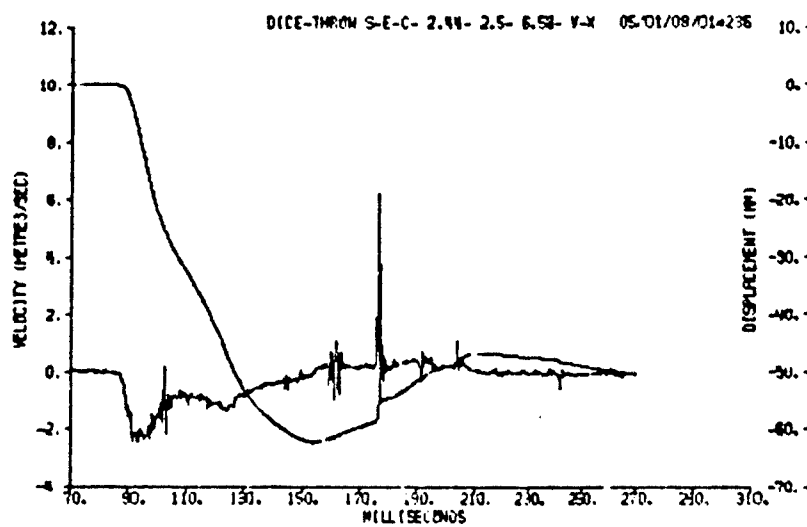
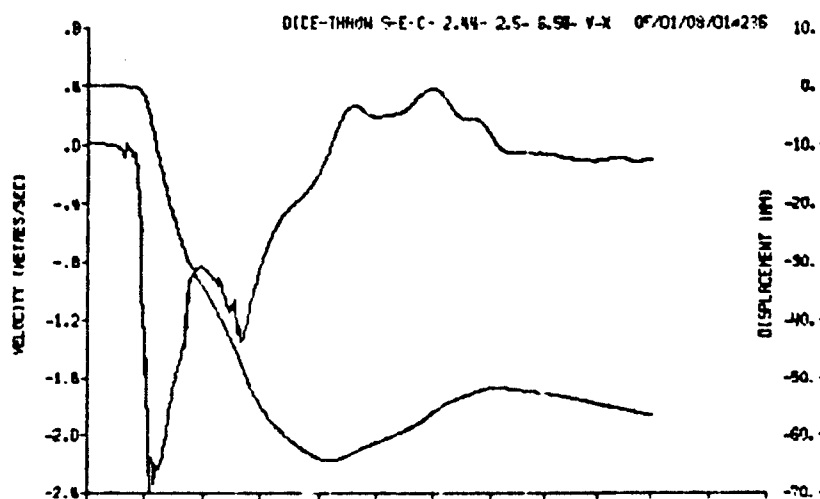
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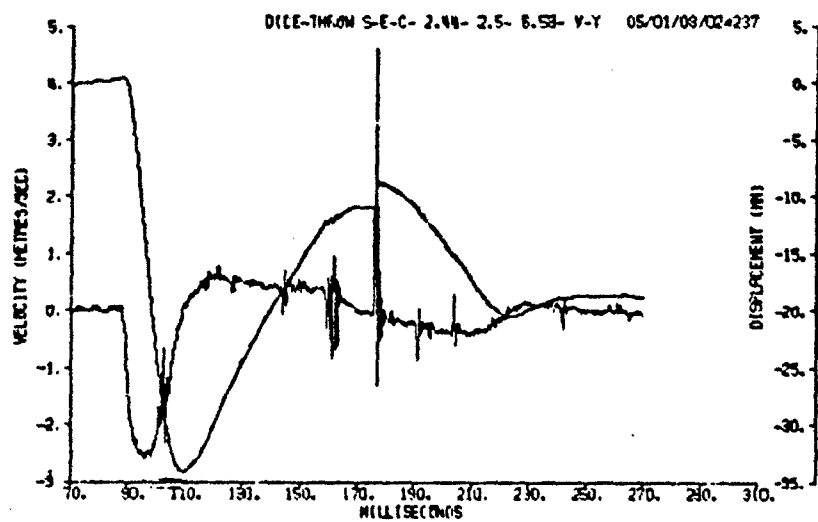
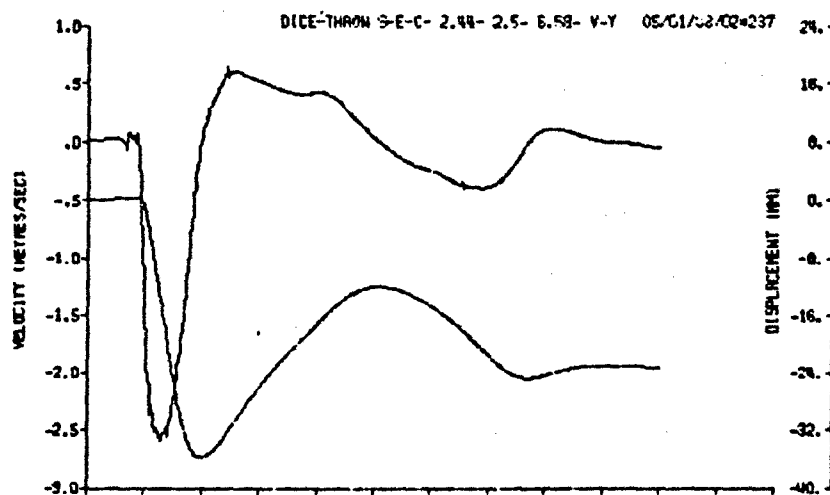
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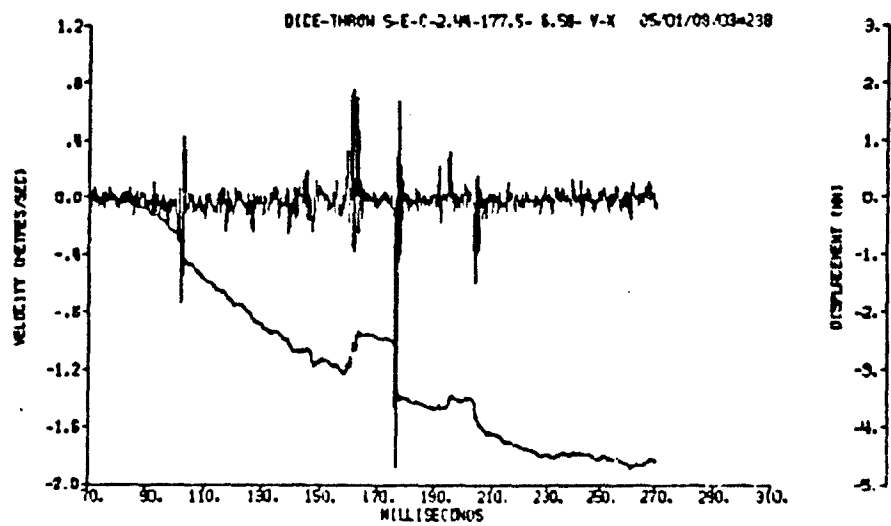
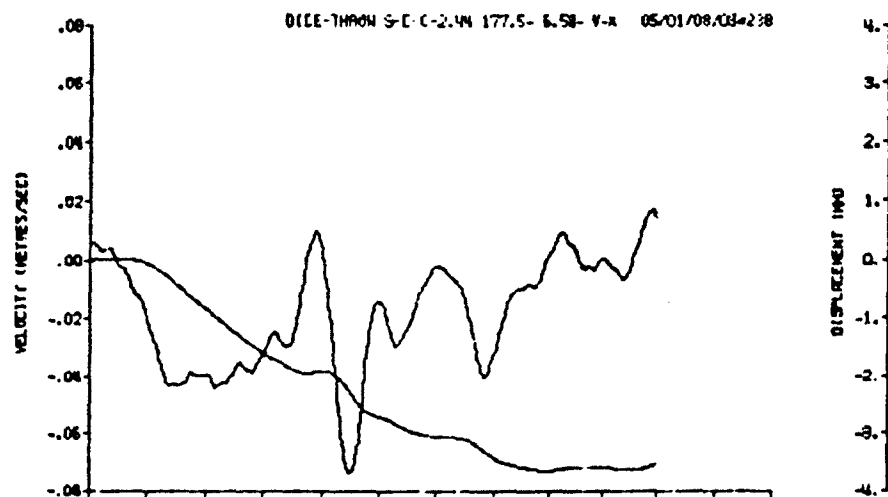


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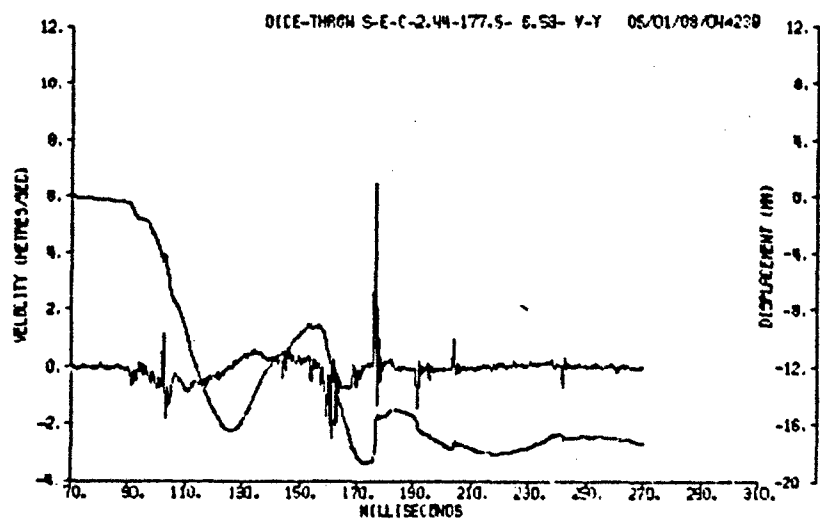
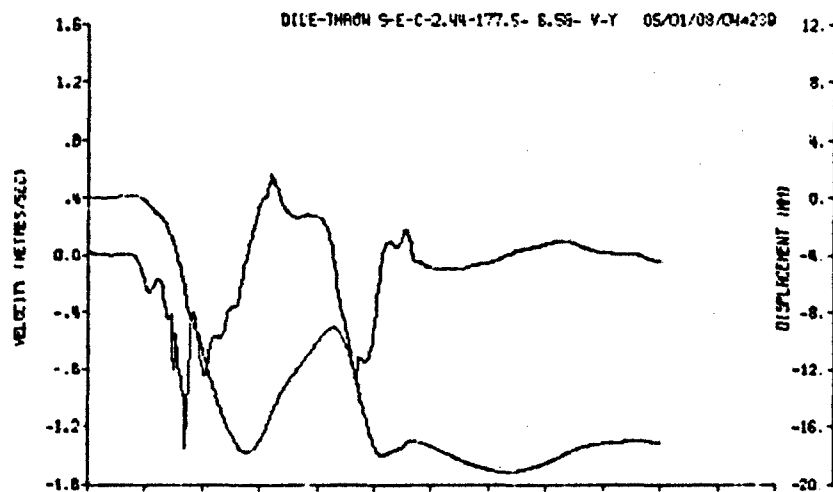


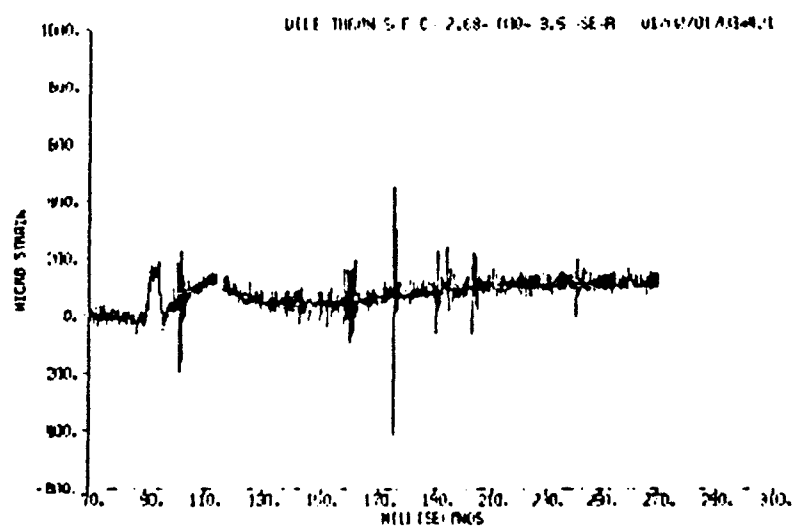
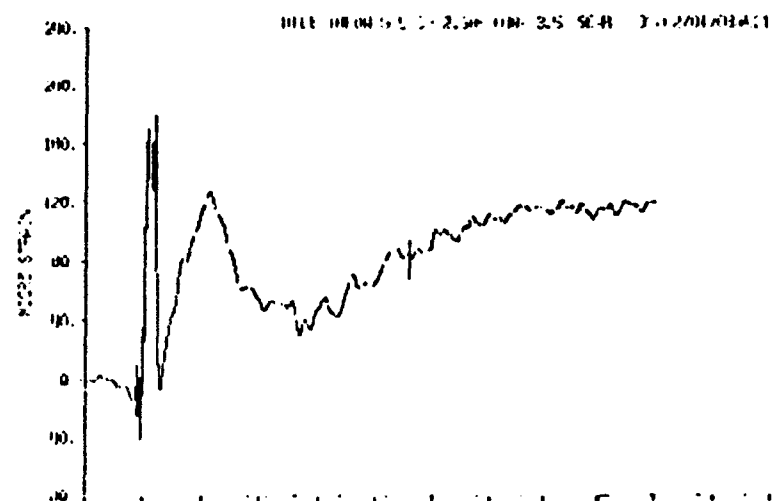
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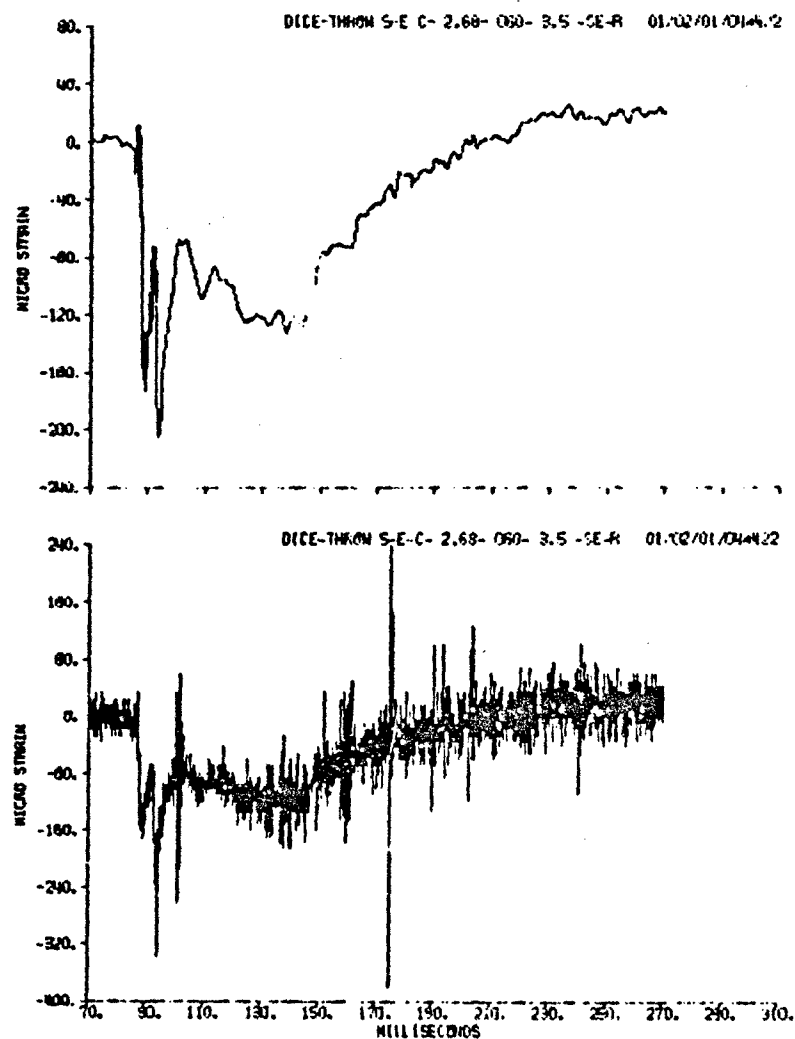


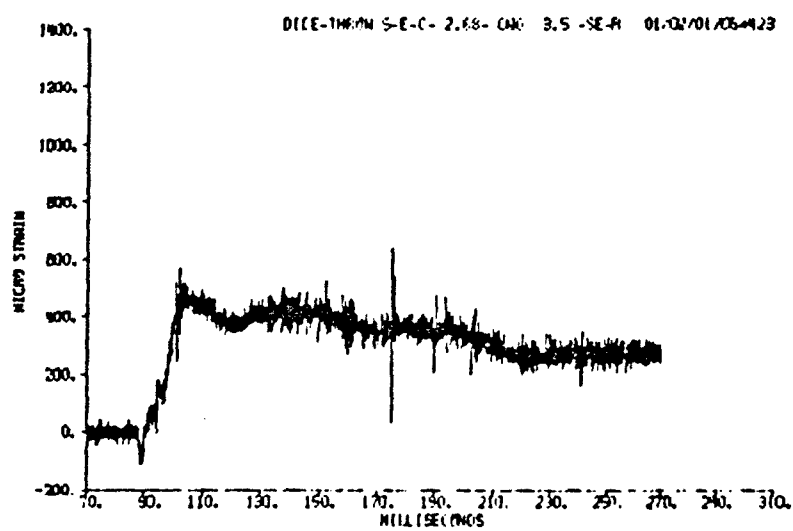
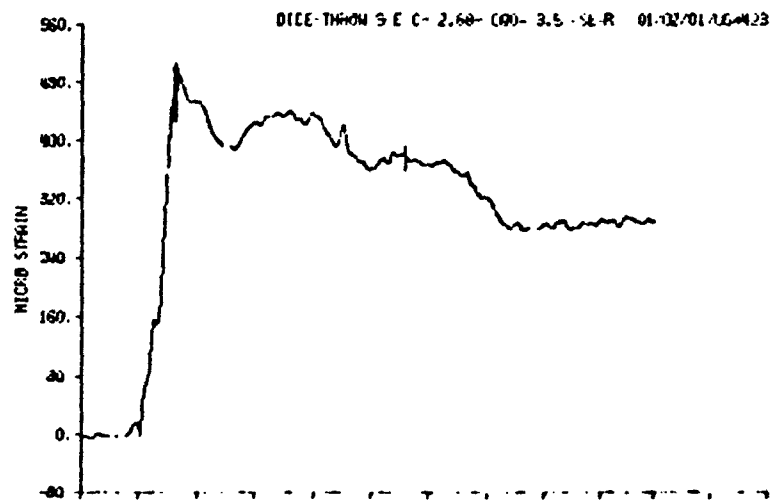
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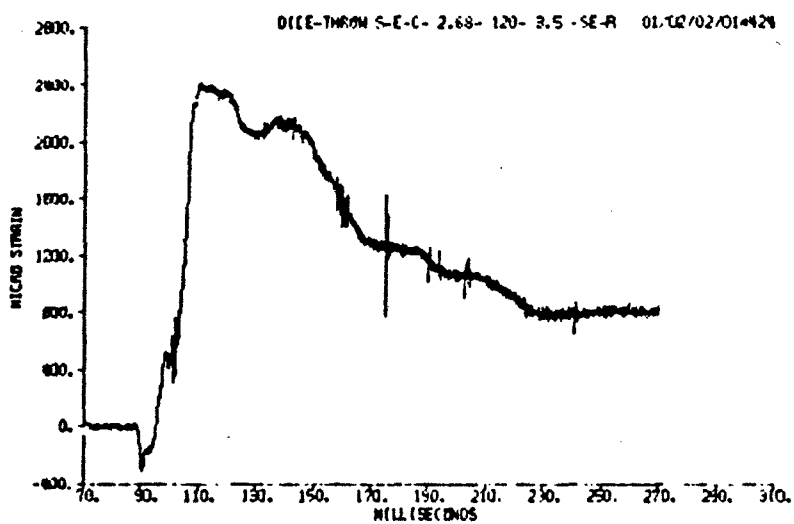
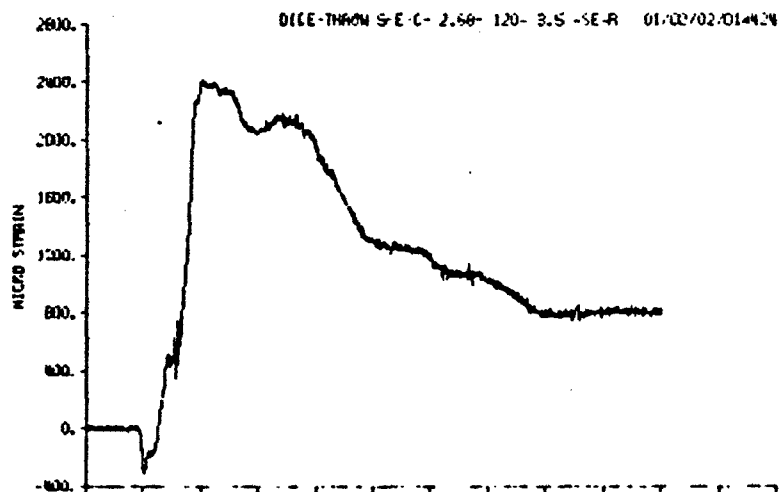


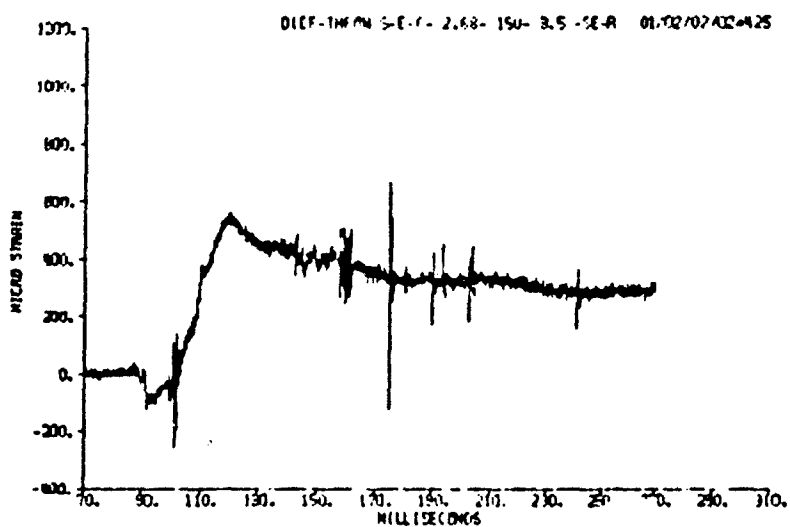
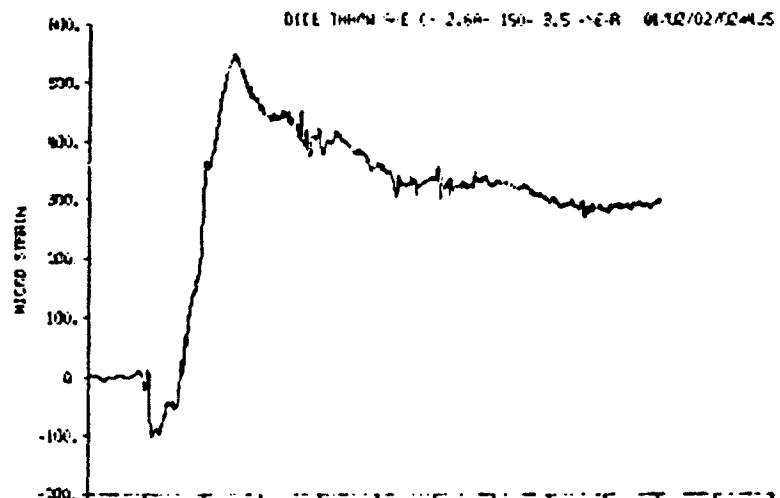


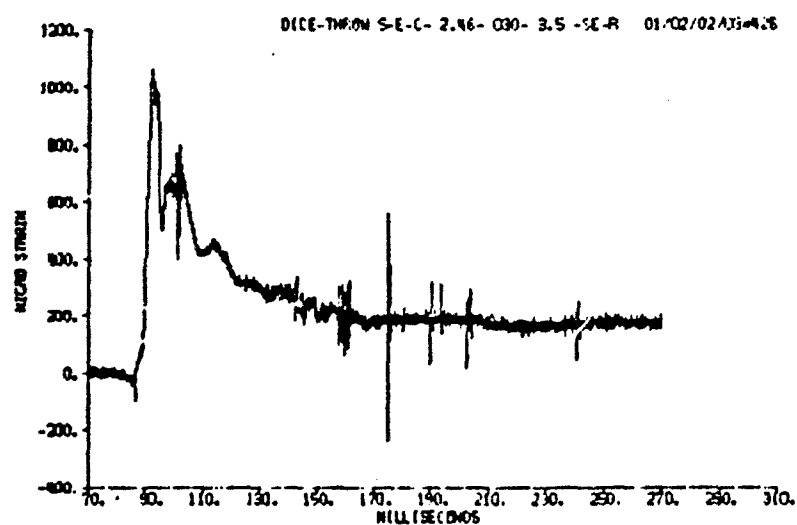
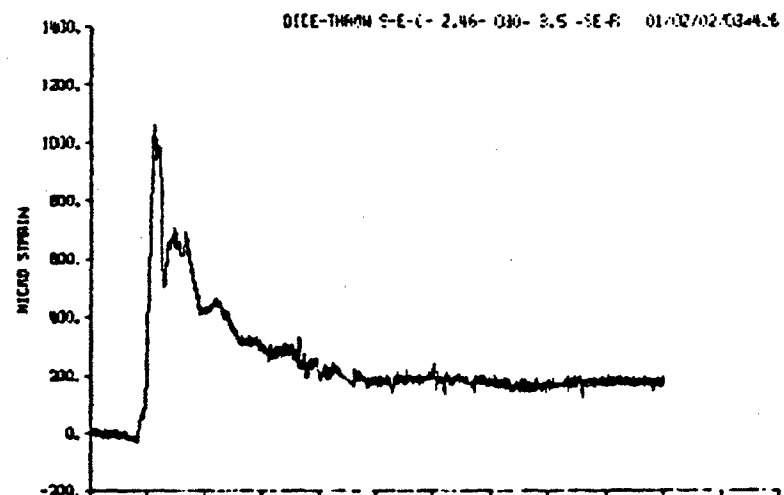


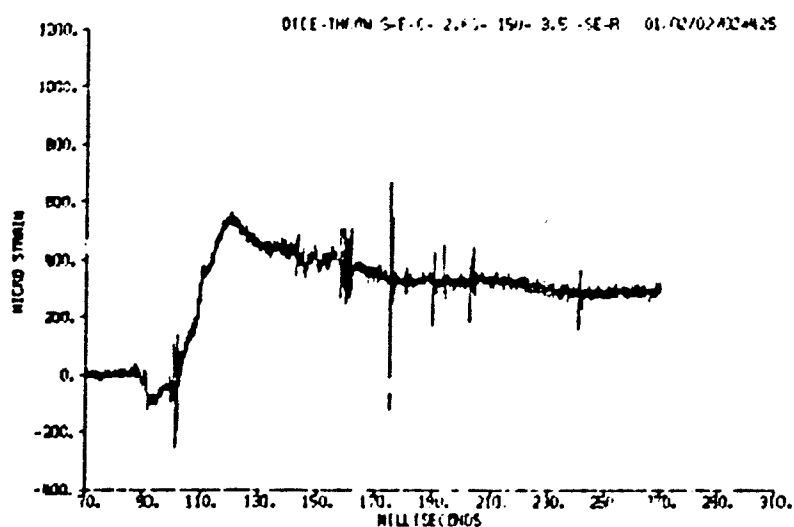
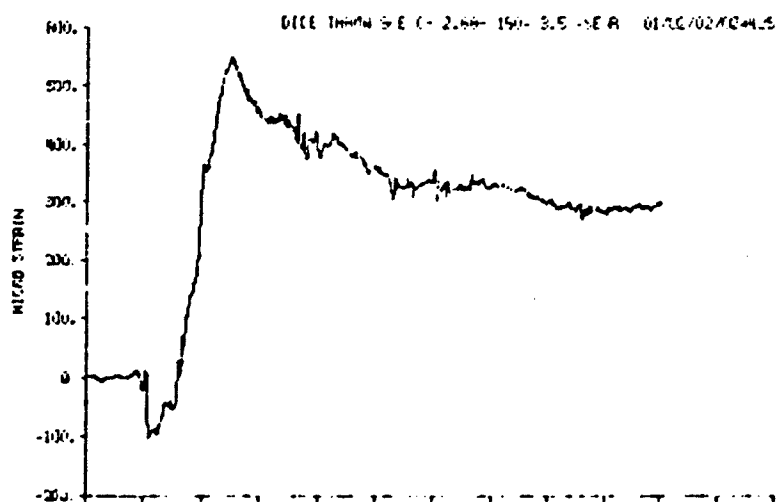




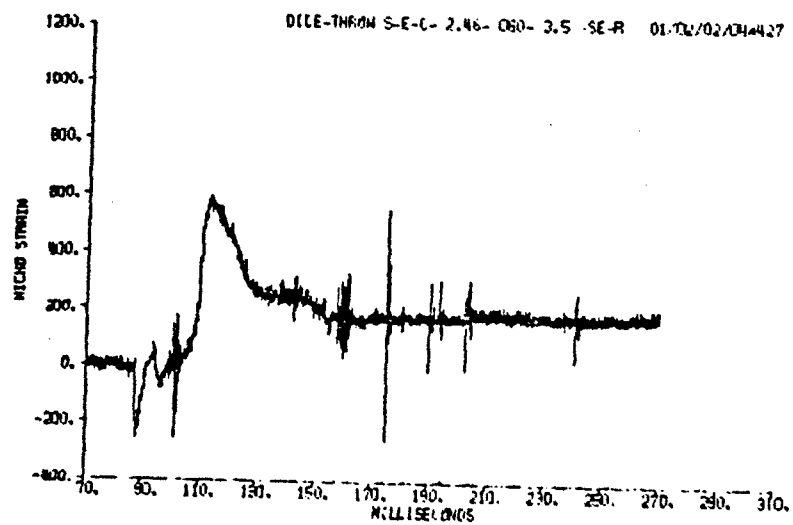
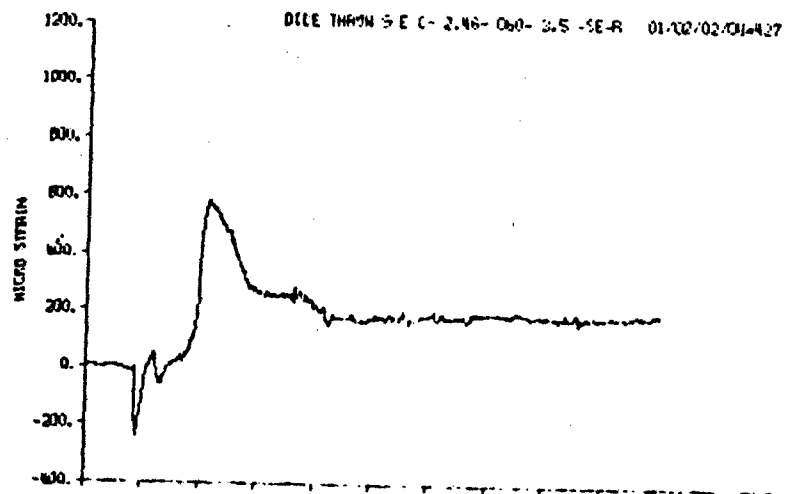




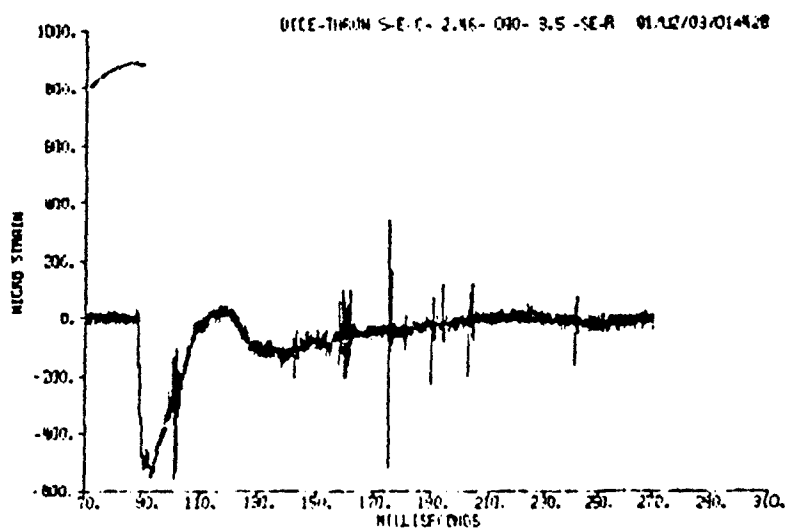
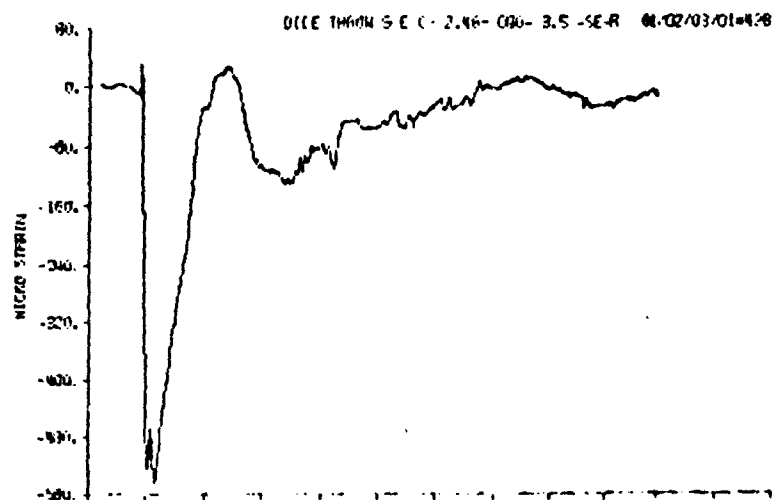




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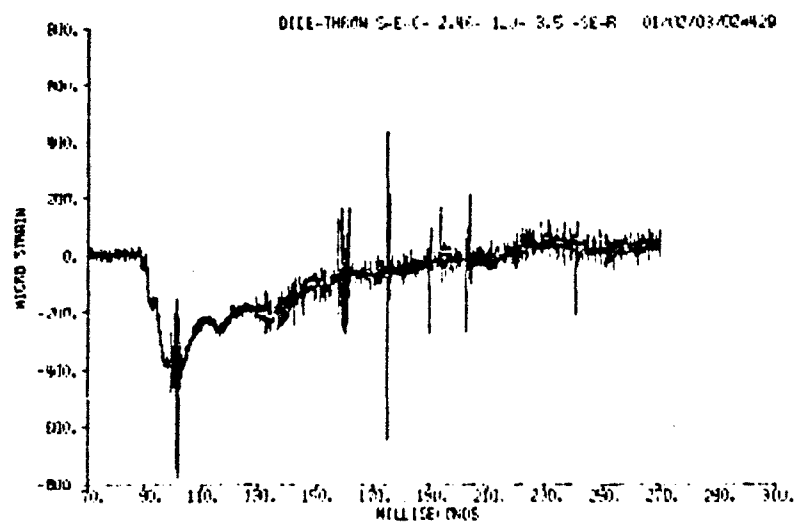
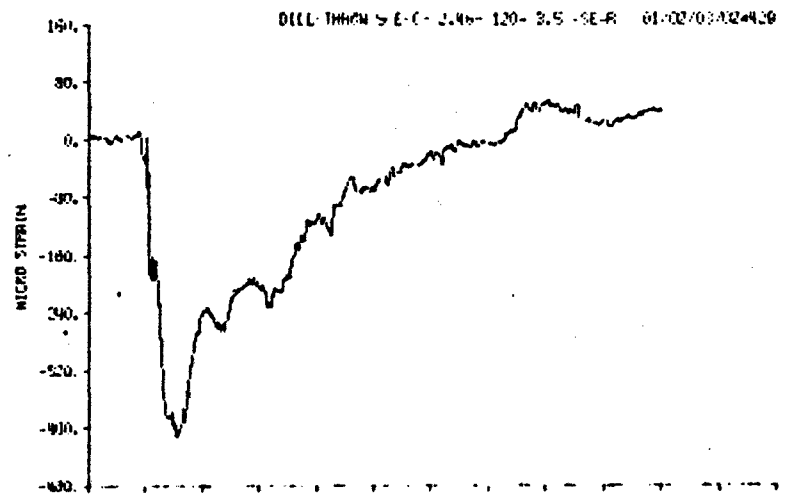


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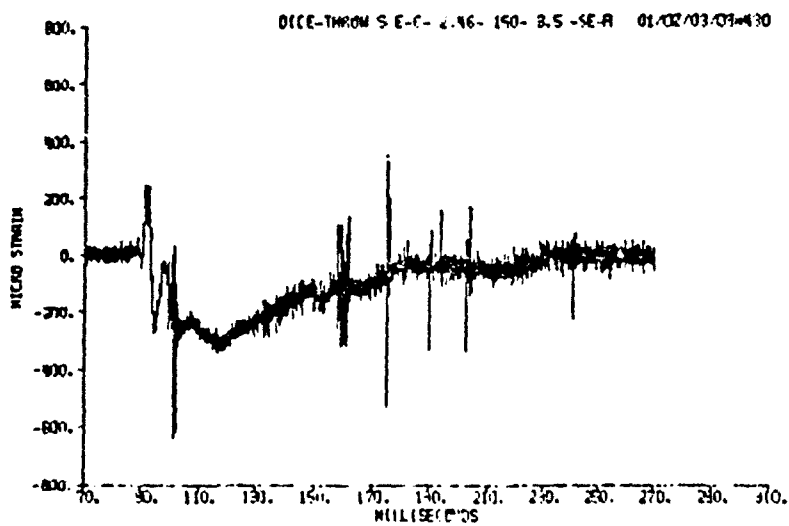
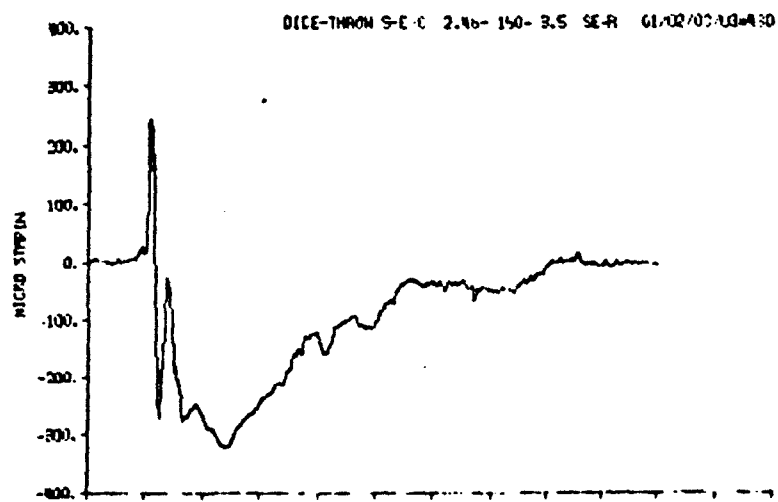




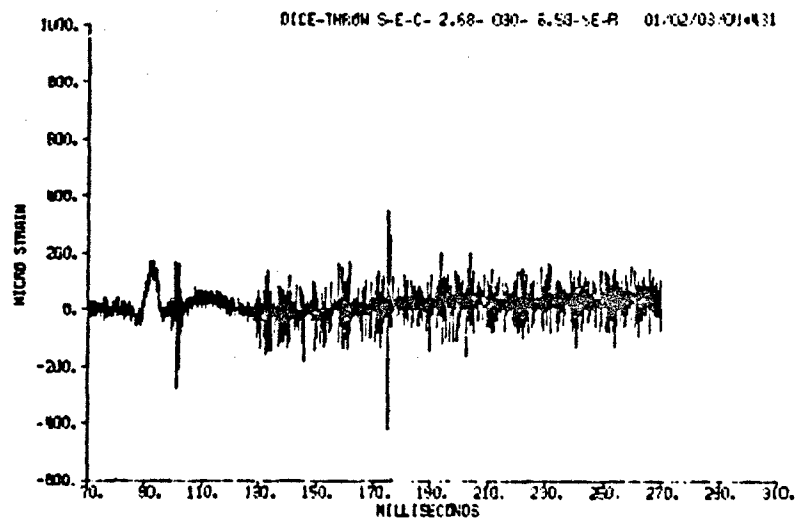
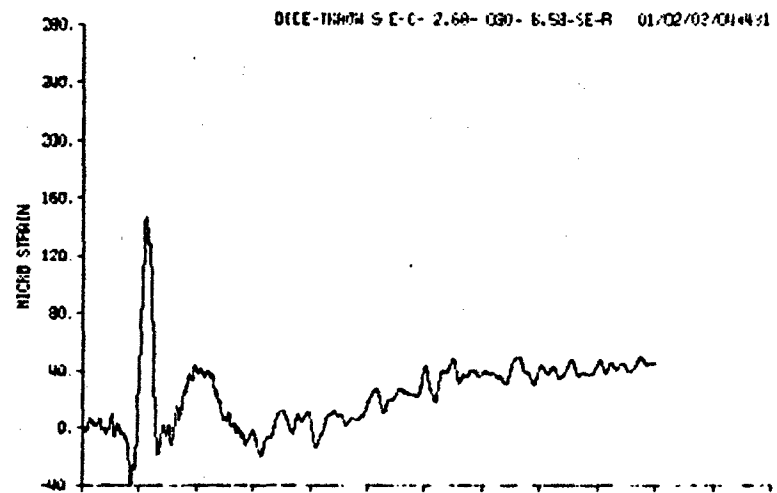
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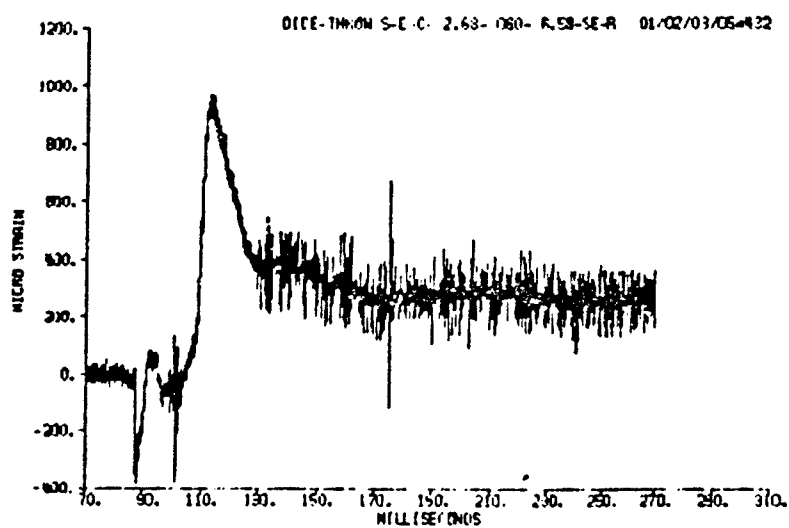
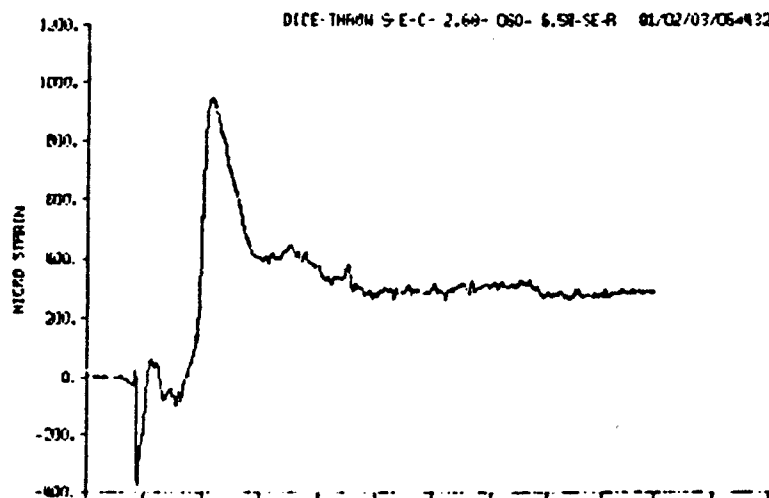
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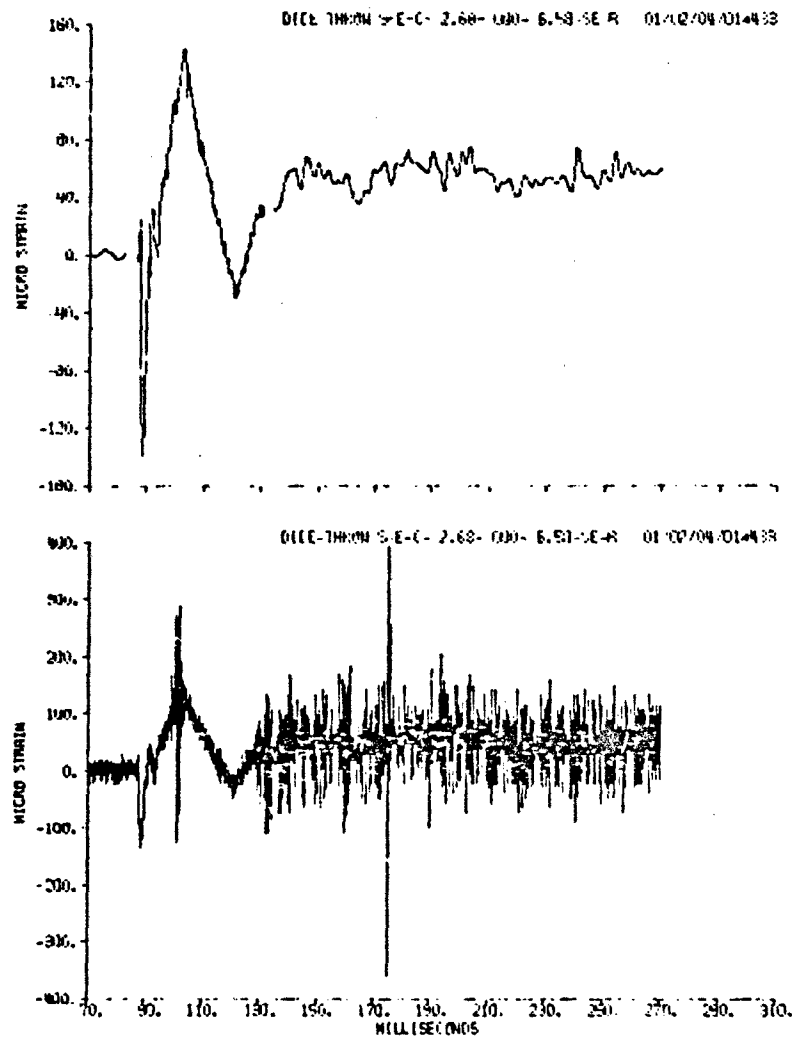
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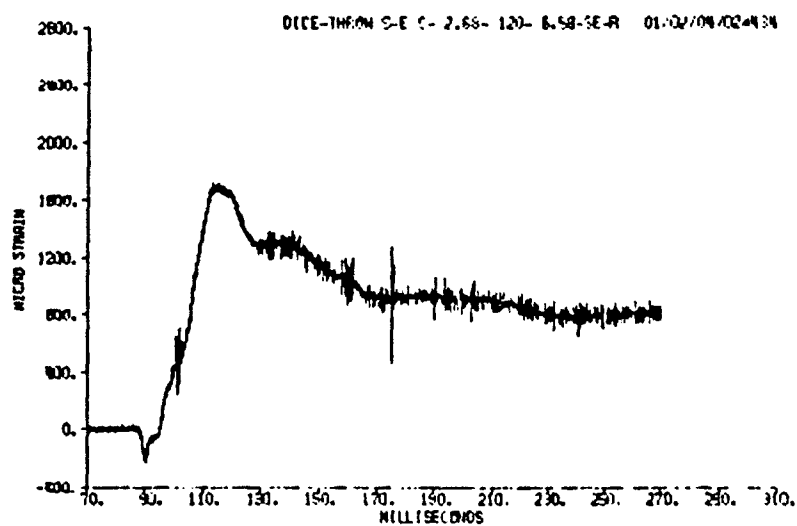
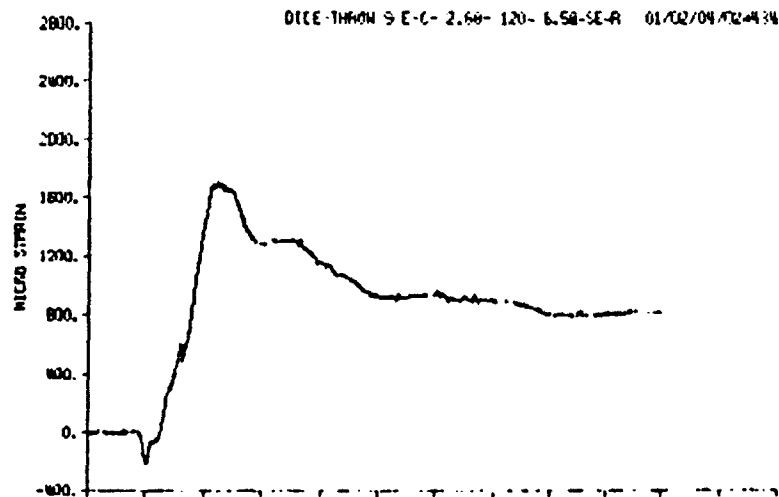


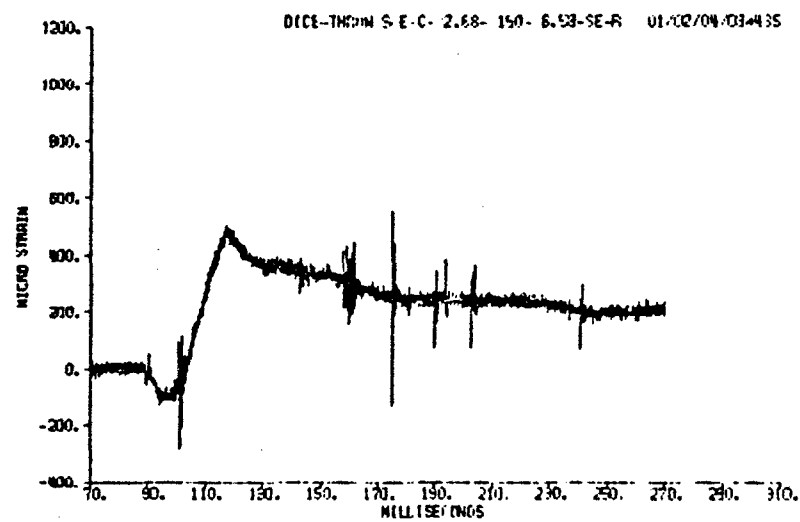
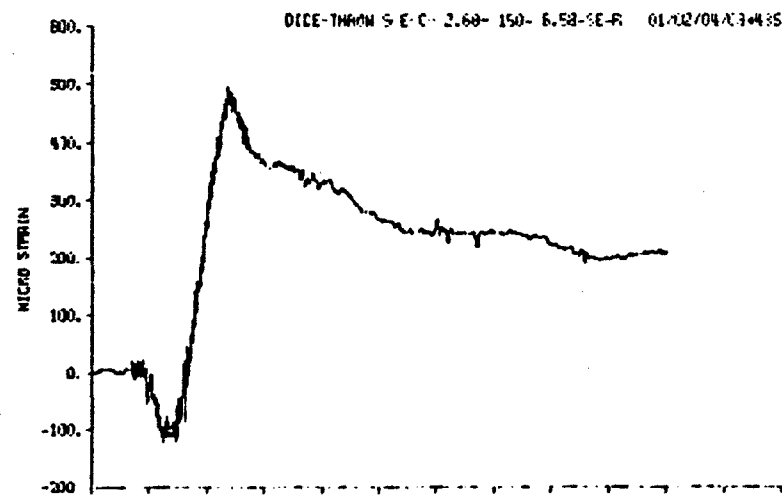
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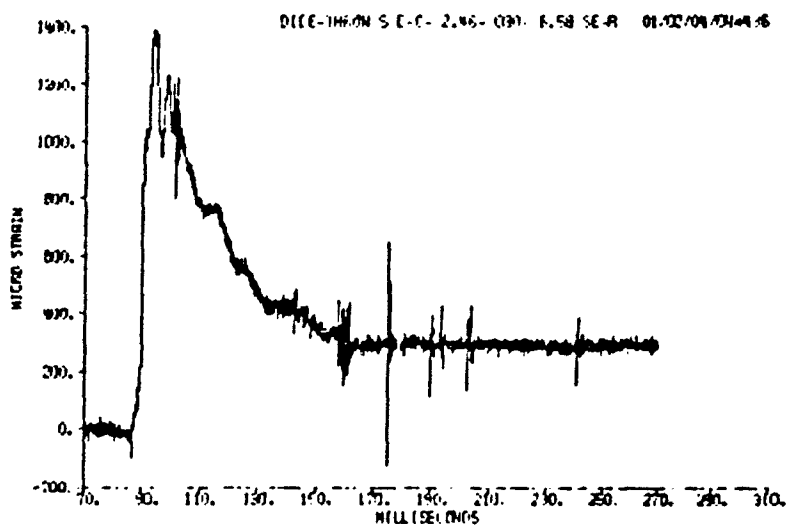
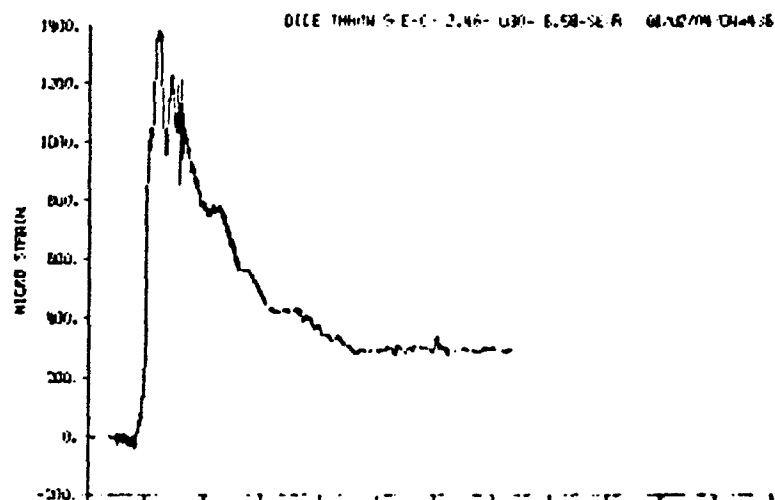


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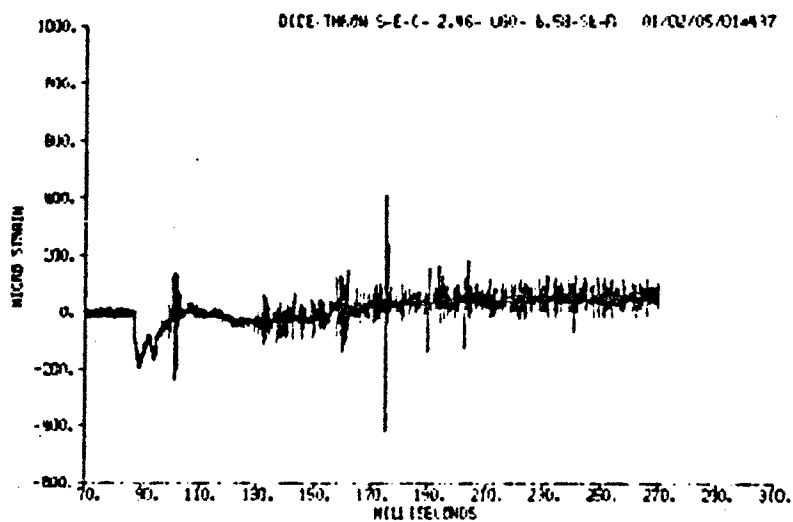
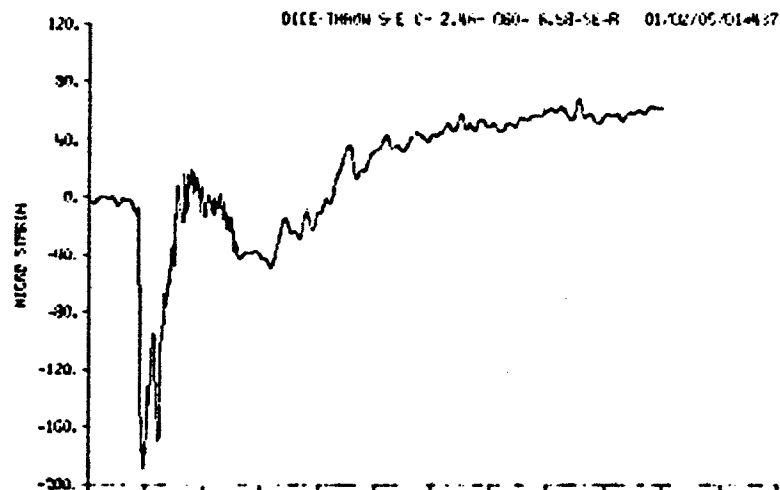


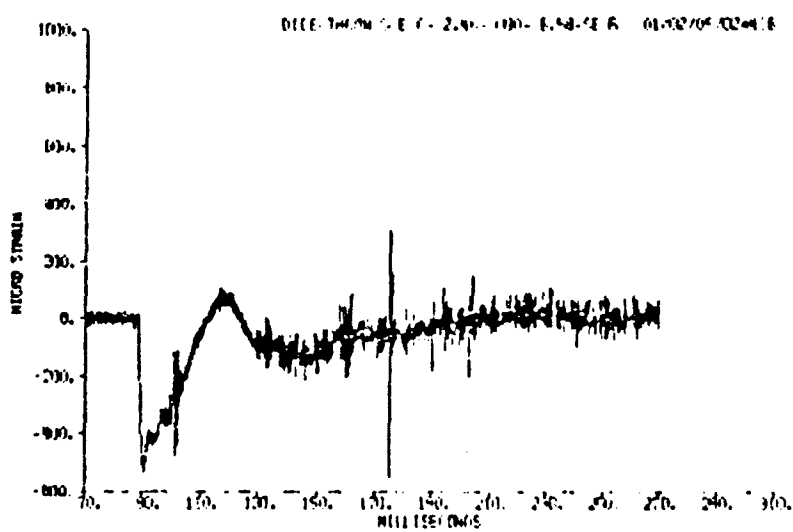
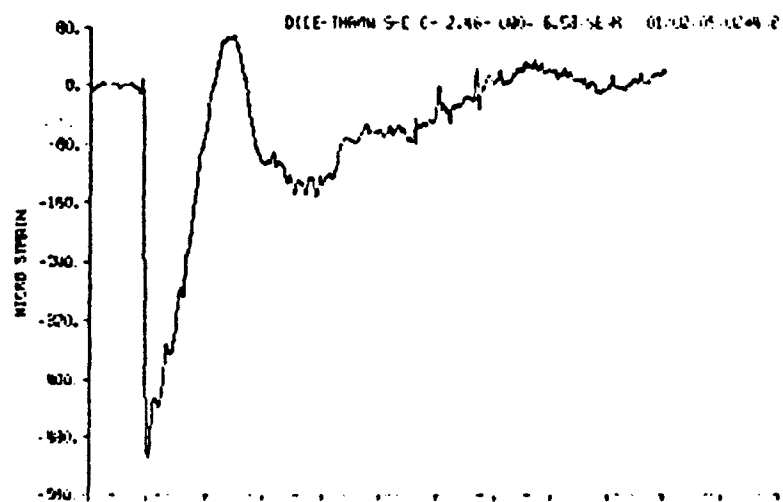


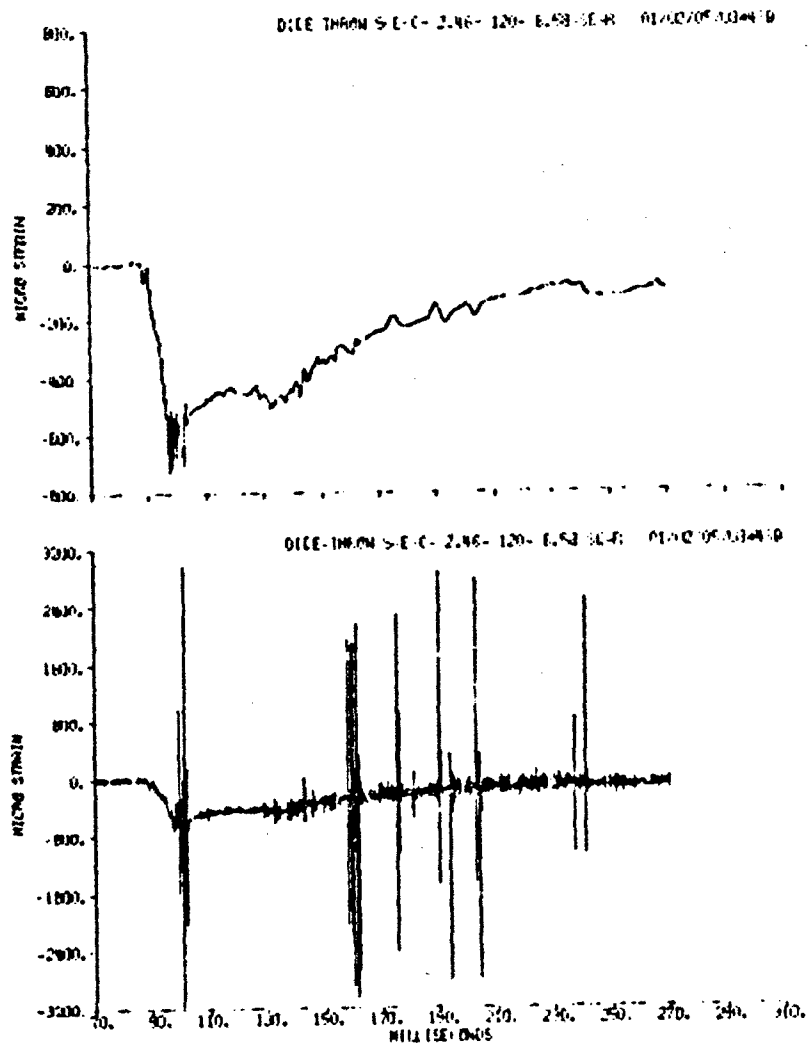


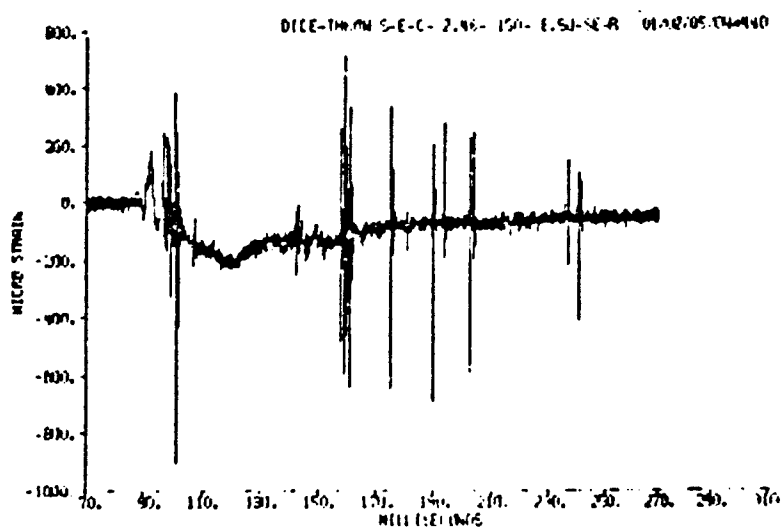
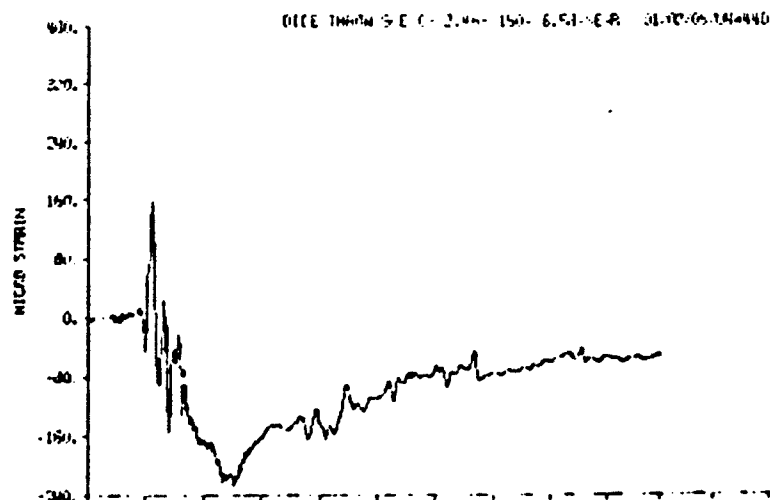




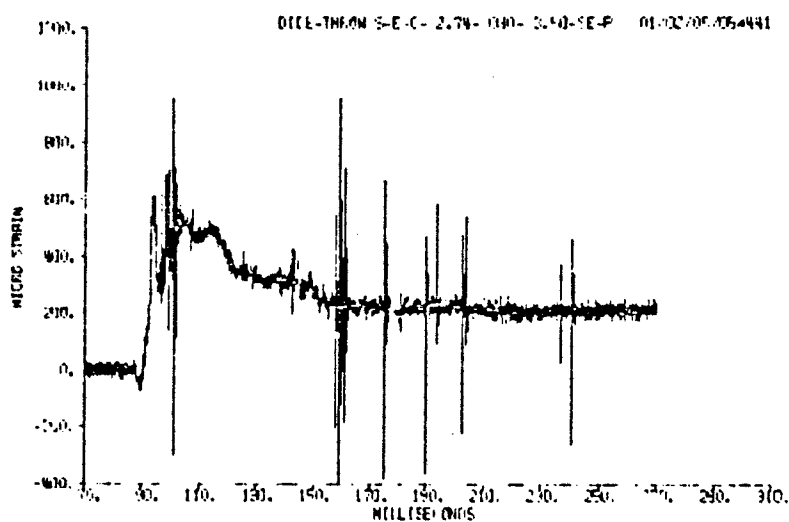
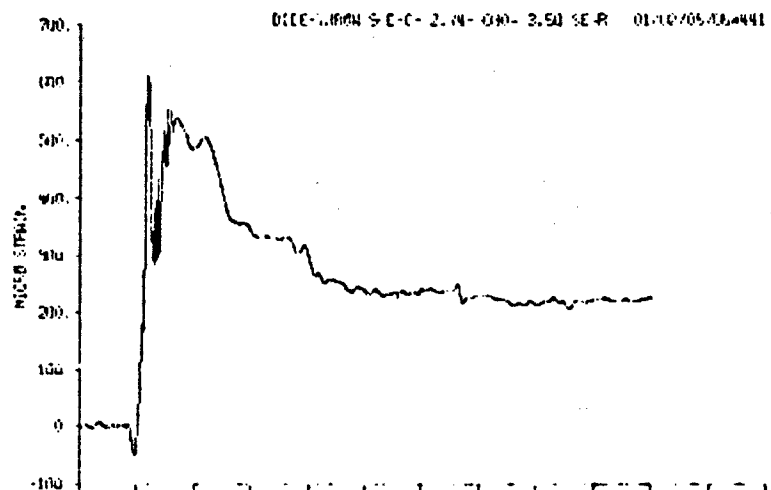




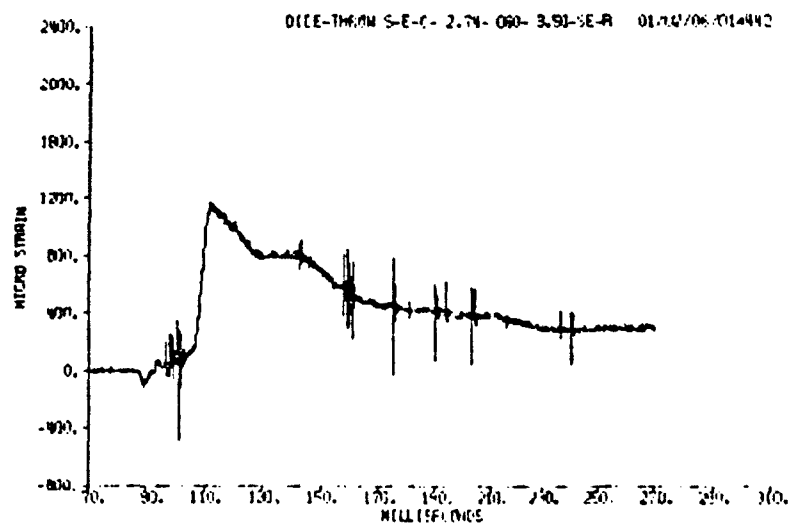
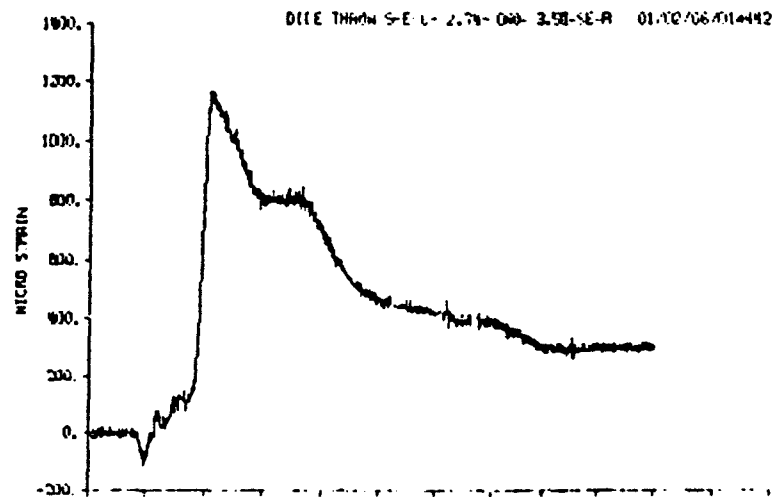




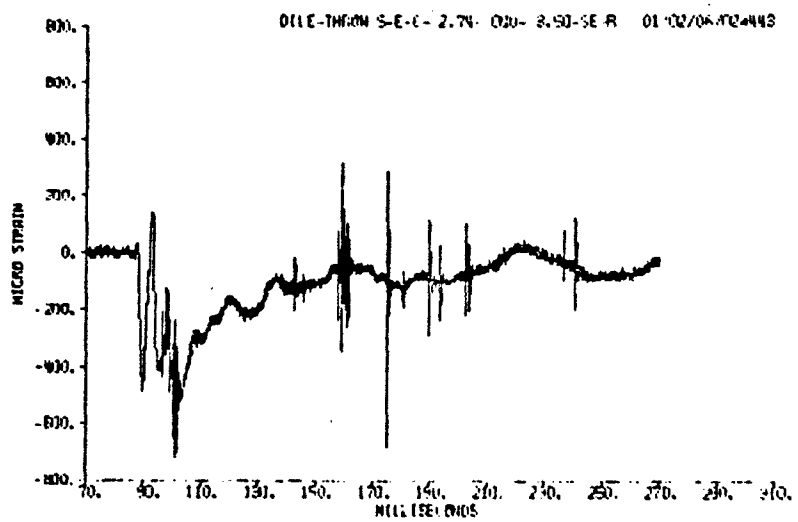
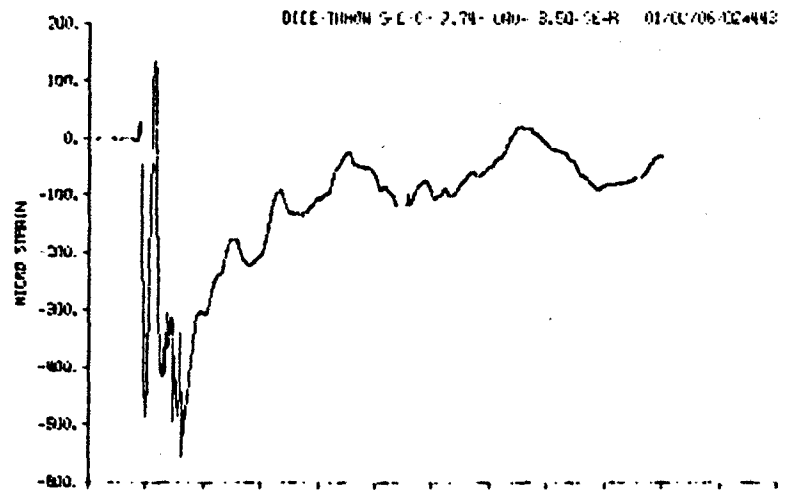
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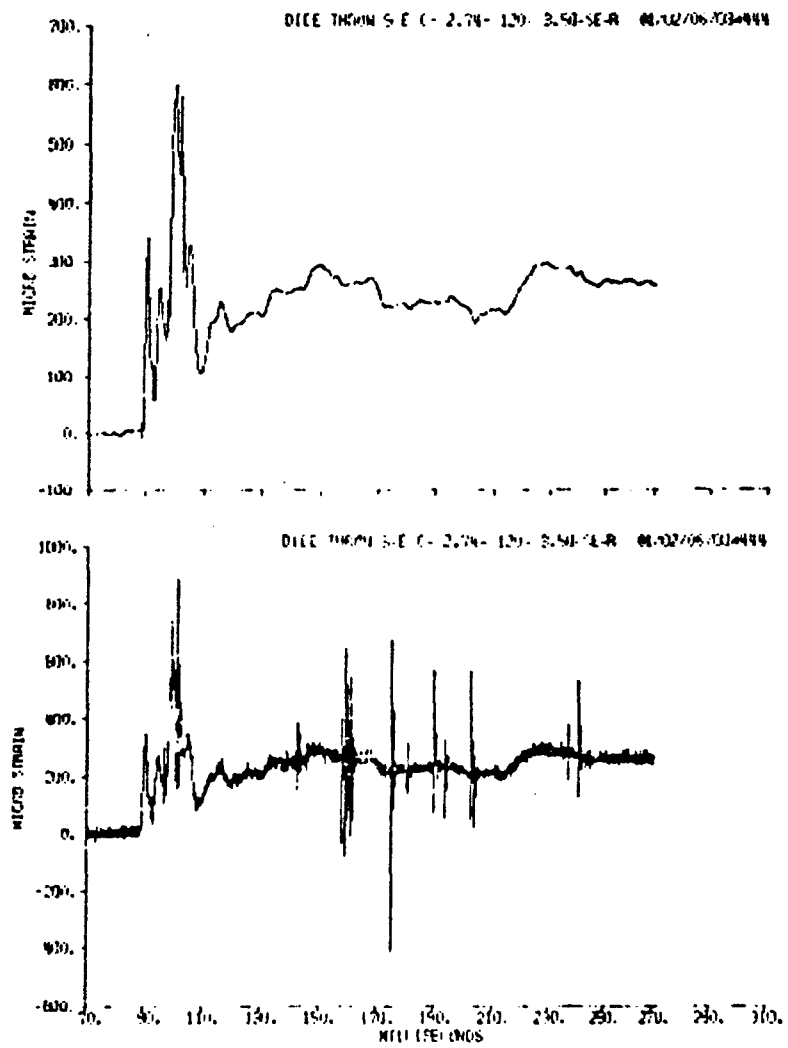
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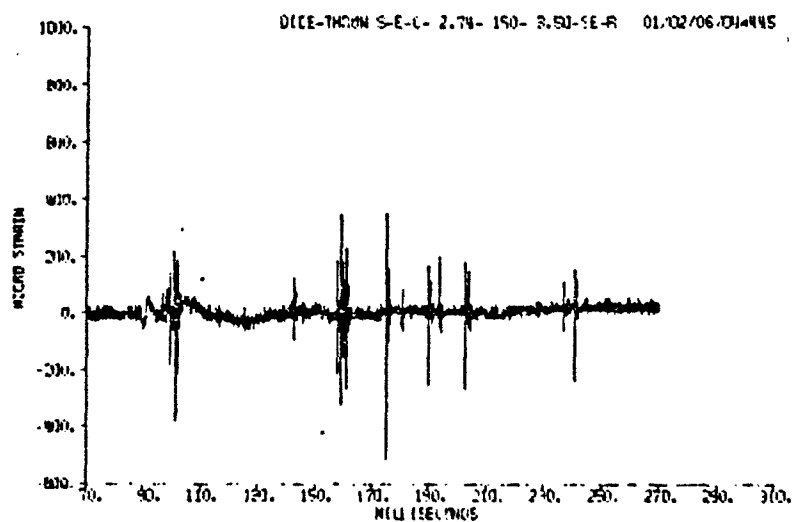
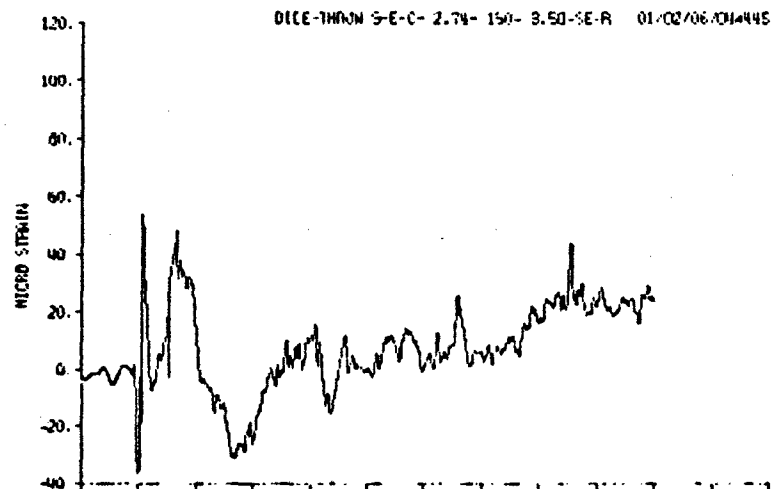


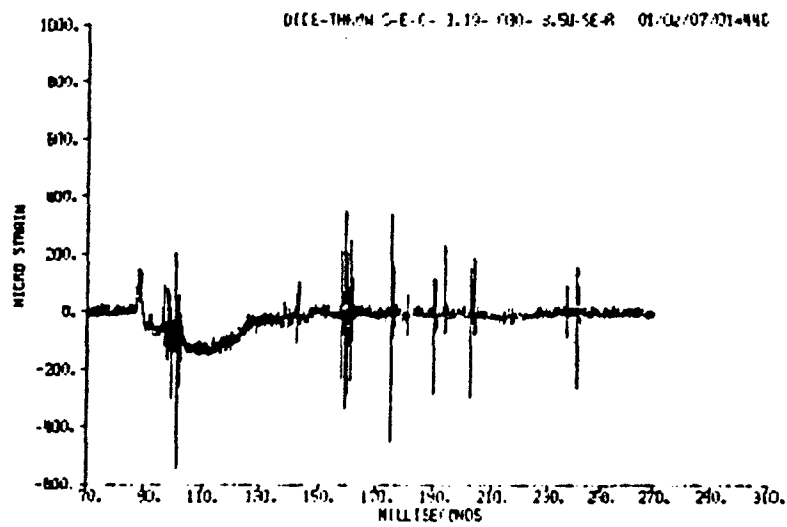
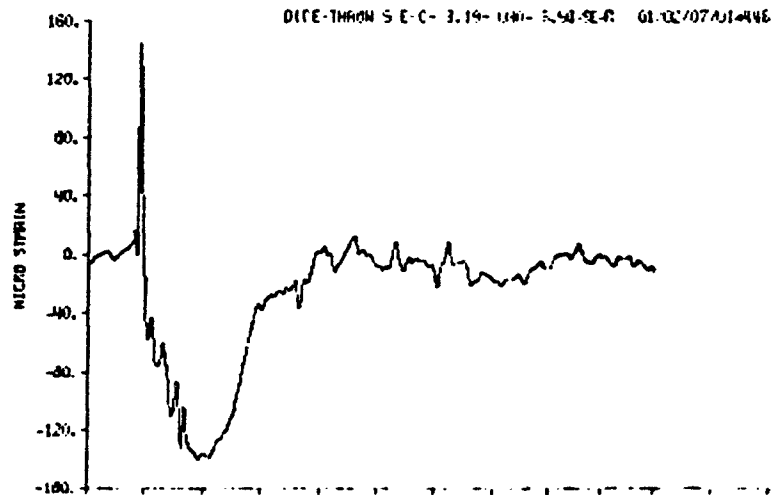
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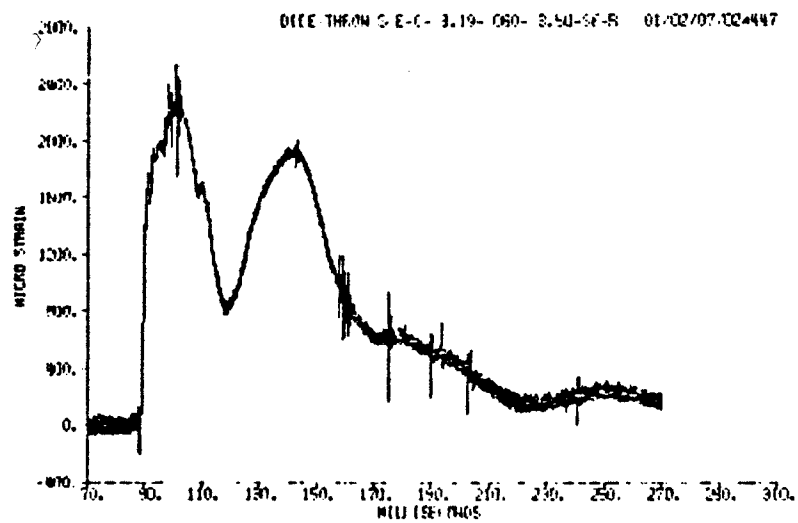
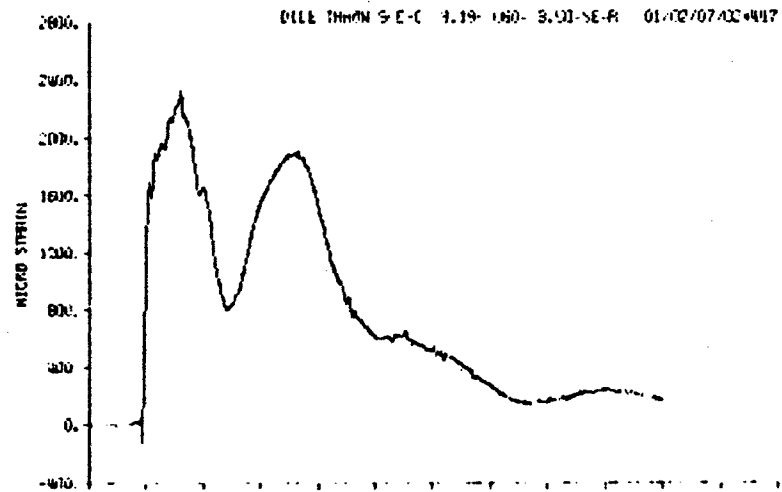


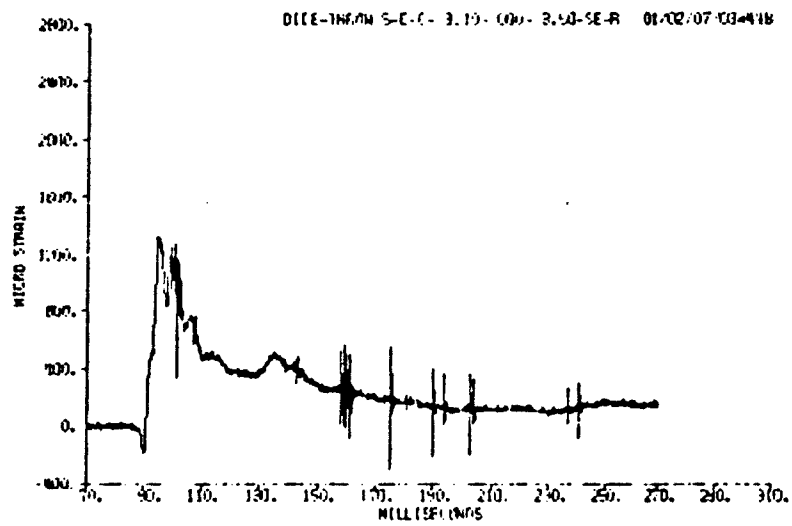
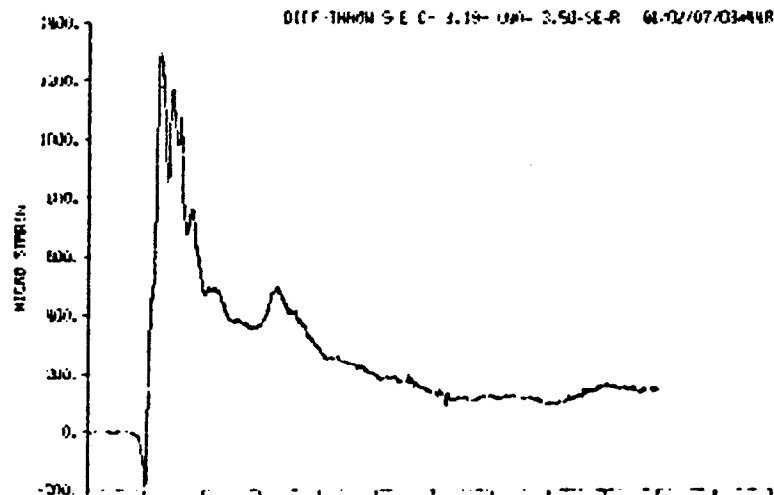
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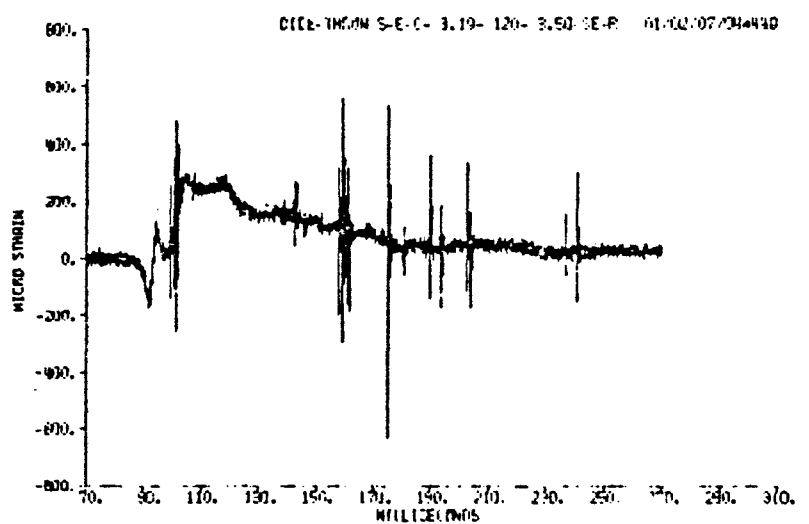
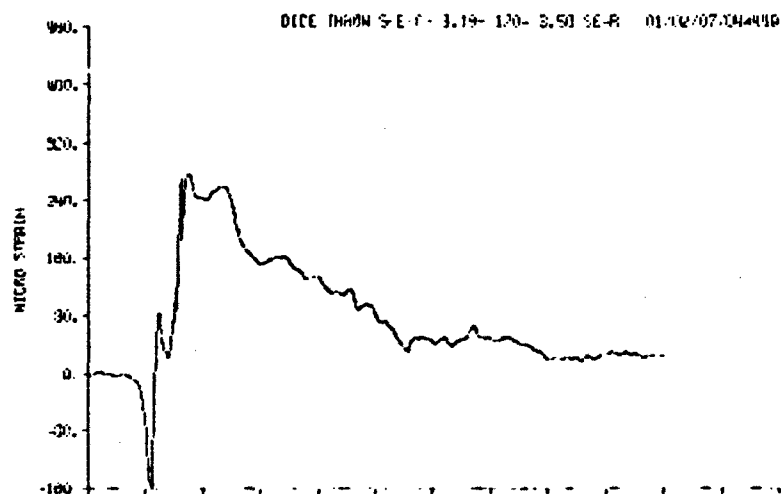


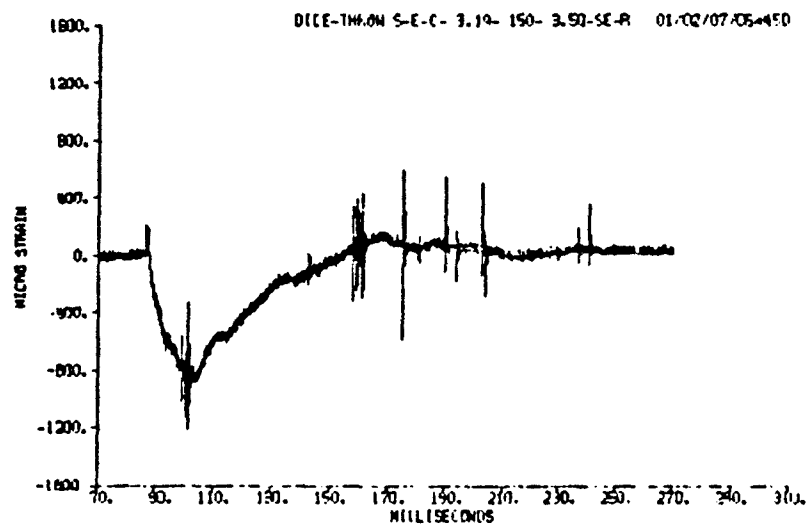
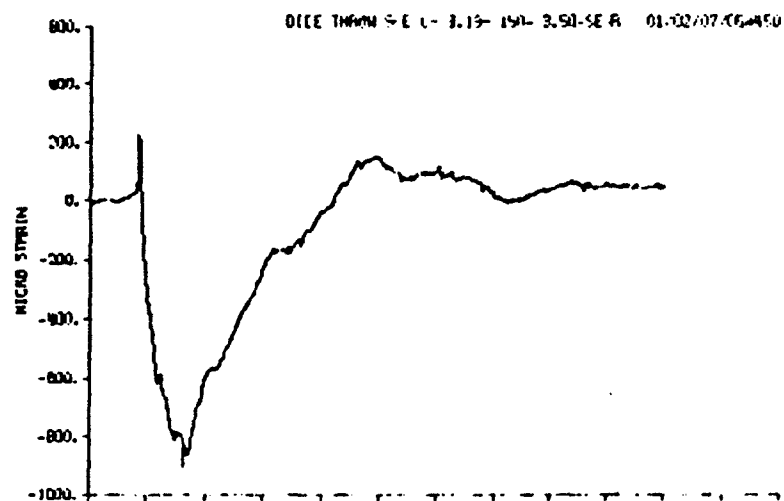


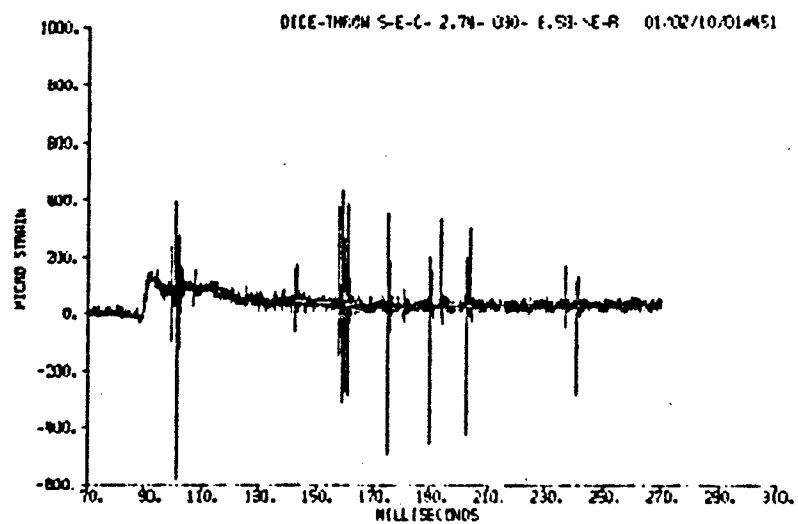
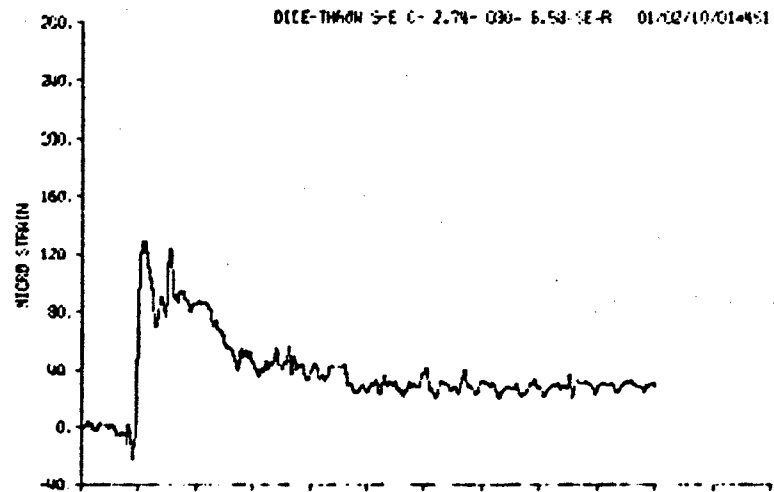
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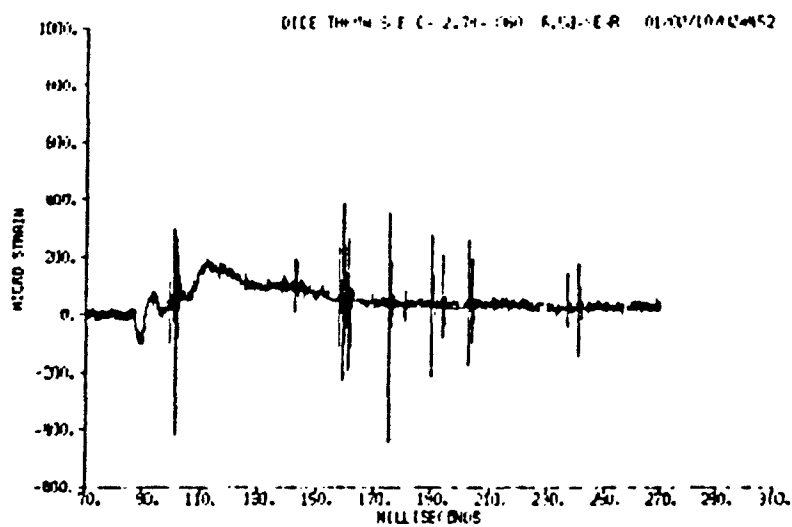
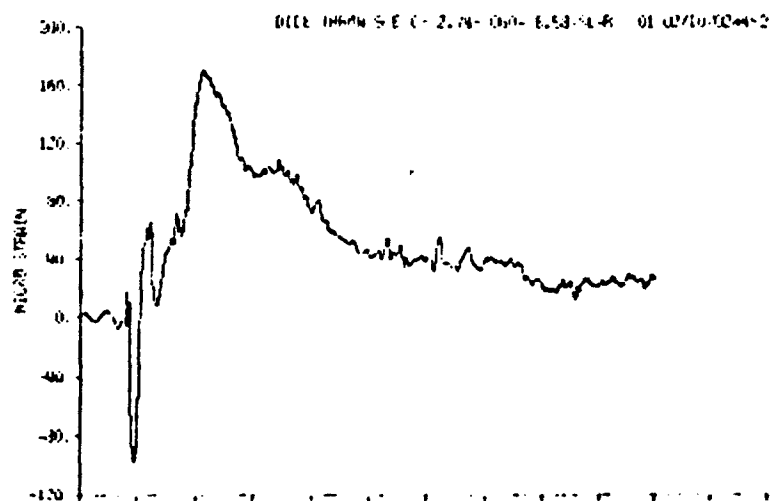




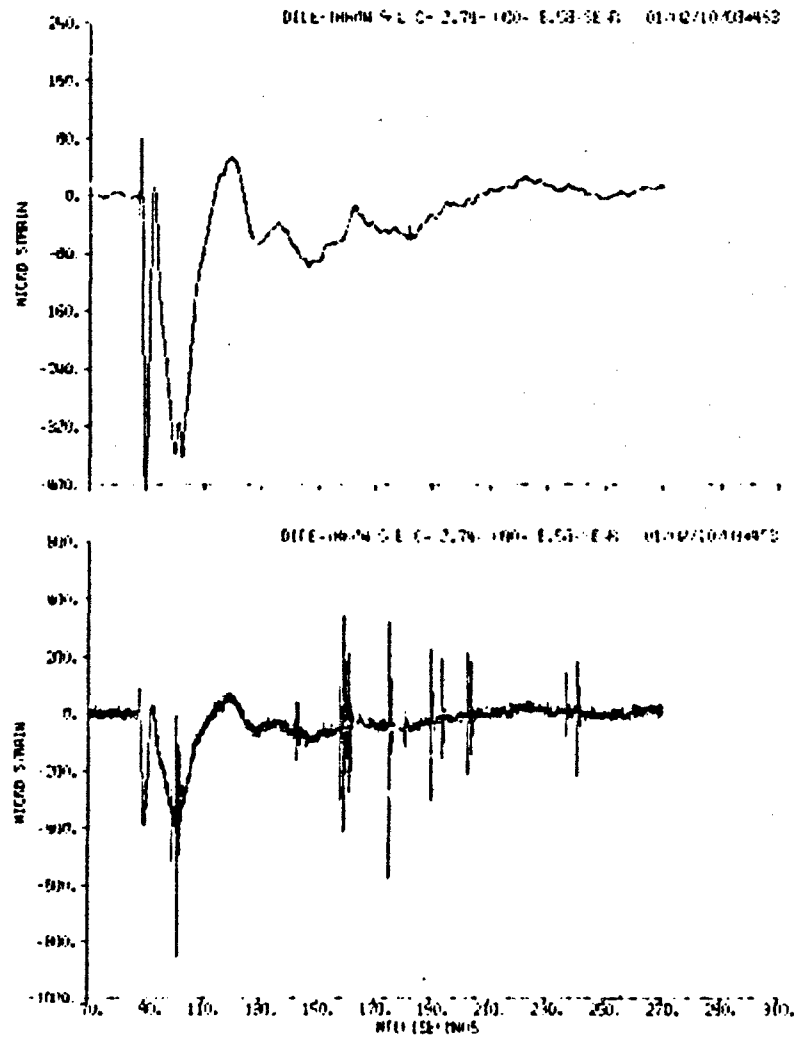


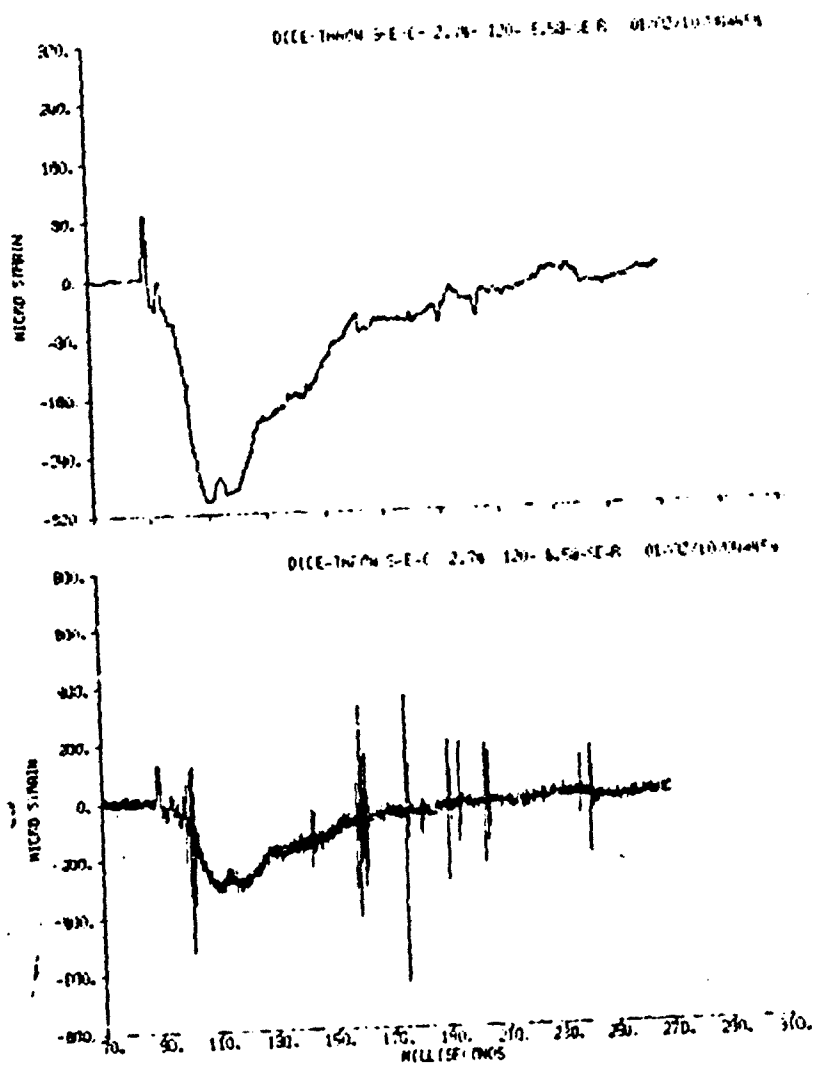




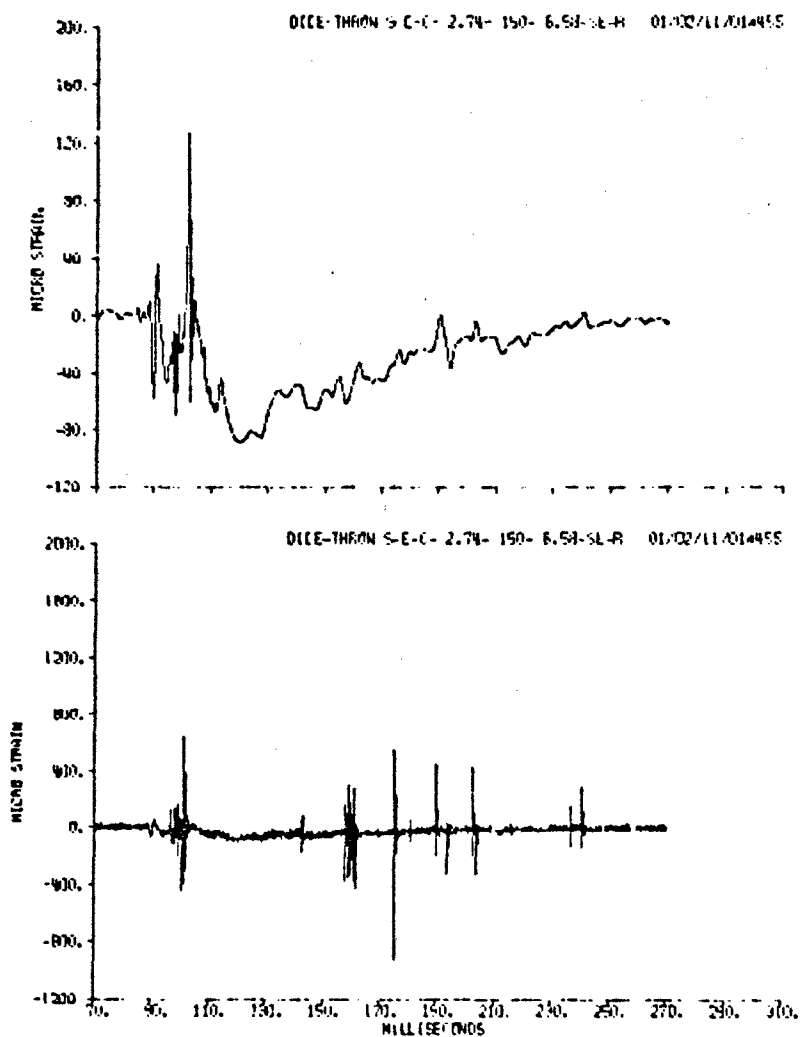




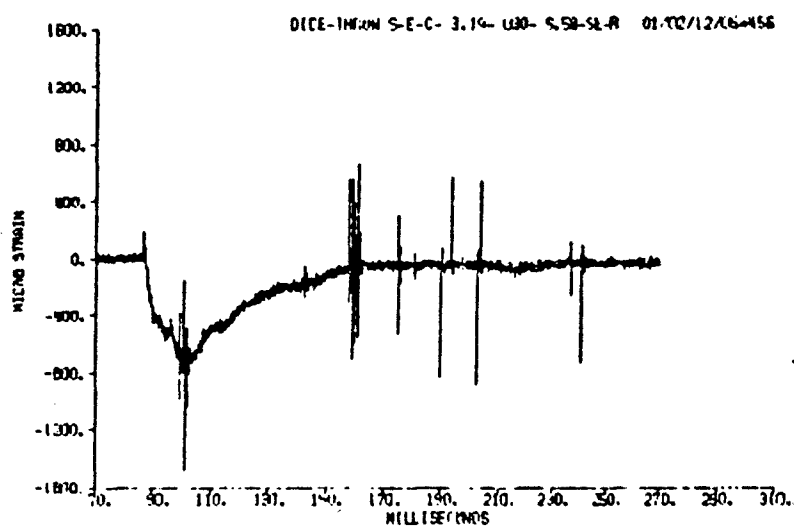
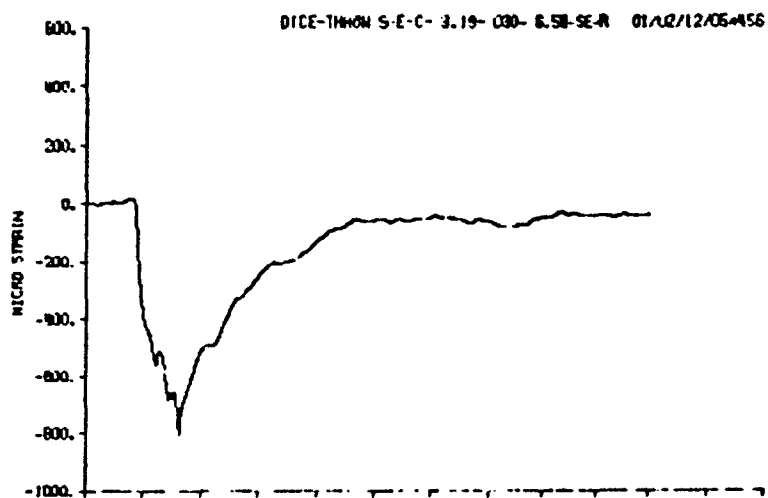




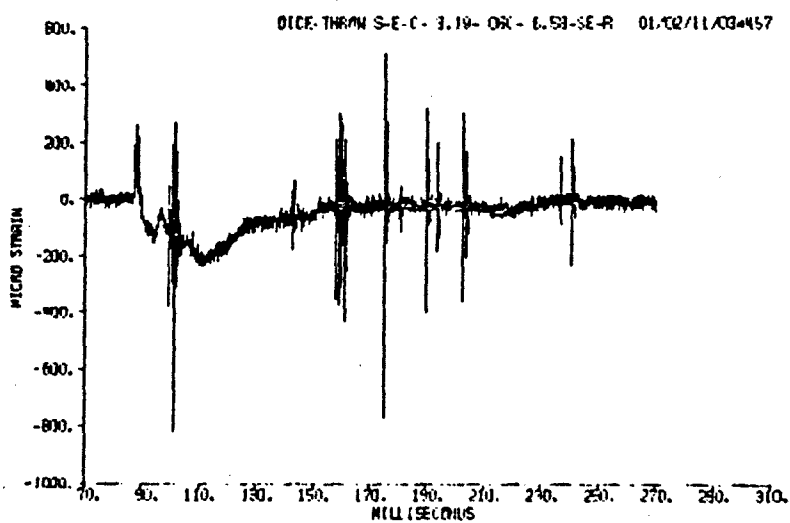
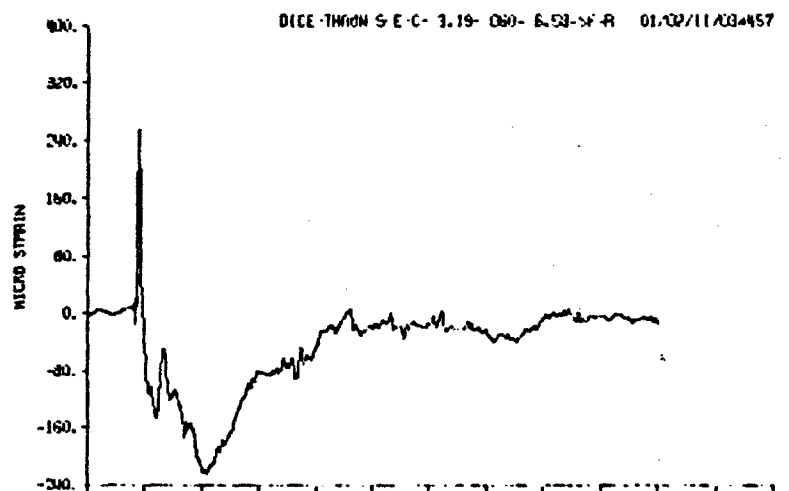
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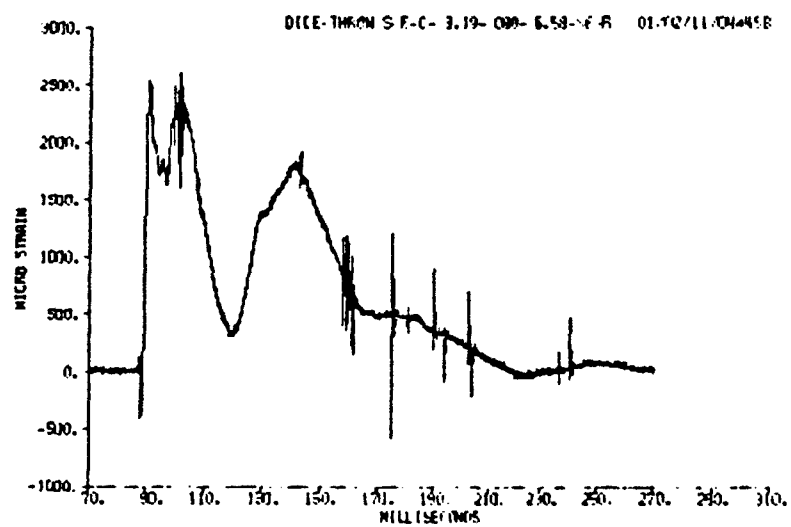
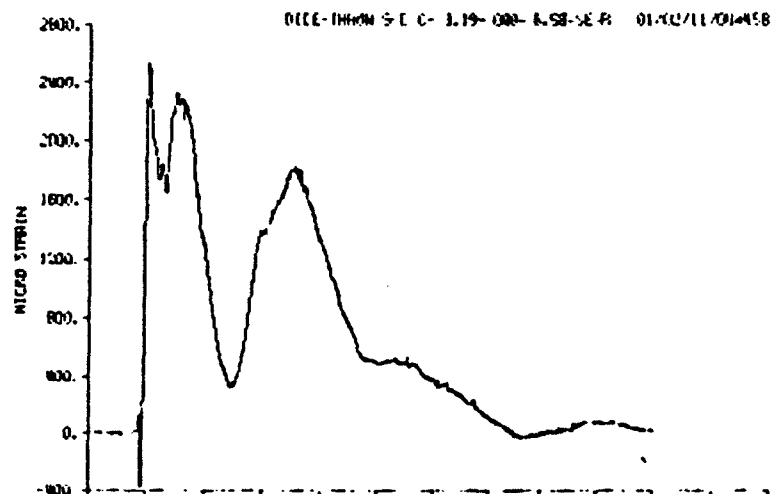
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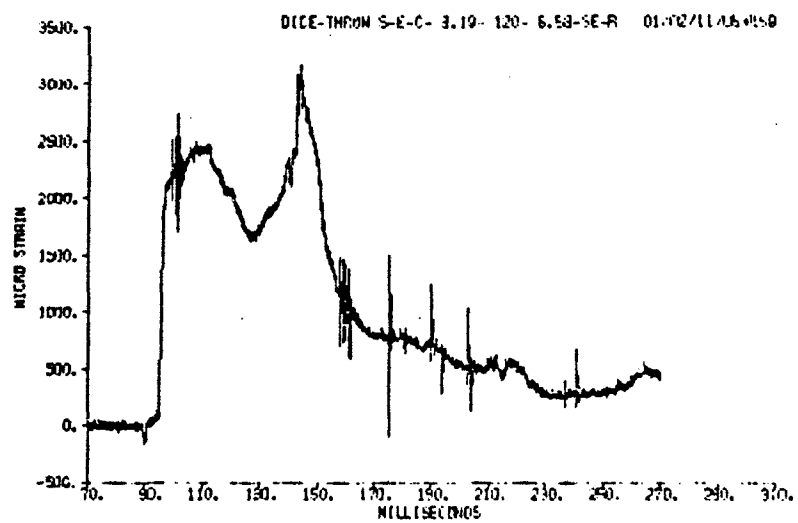
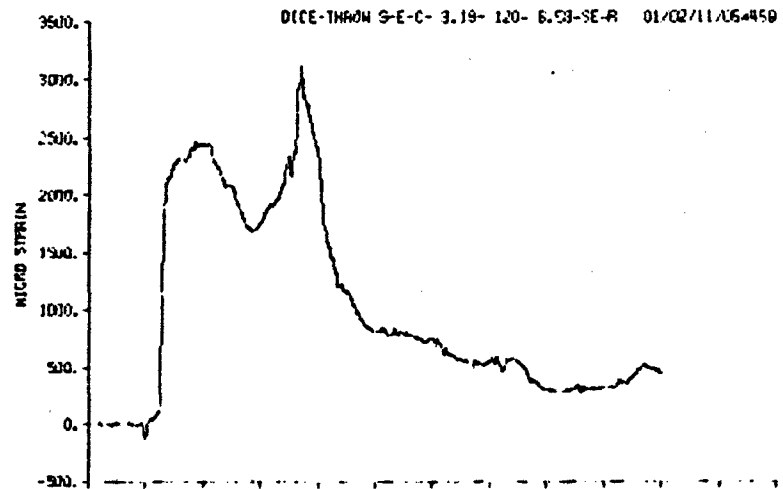
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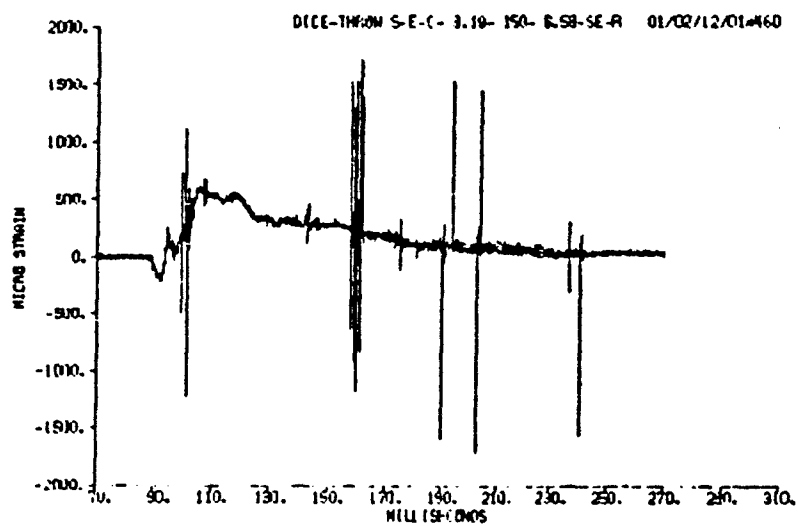
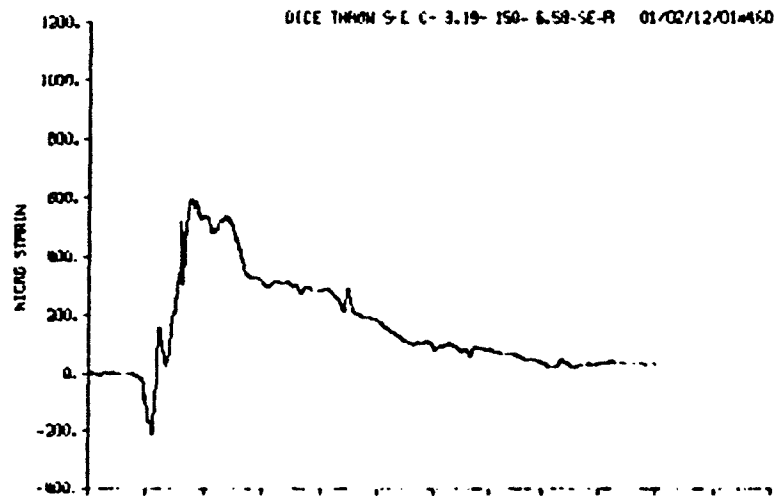
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APPENDIX G  
AIRCRAFT SHELTER "D" DATA PRESENTATION

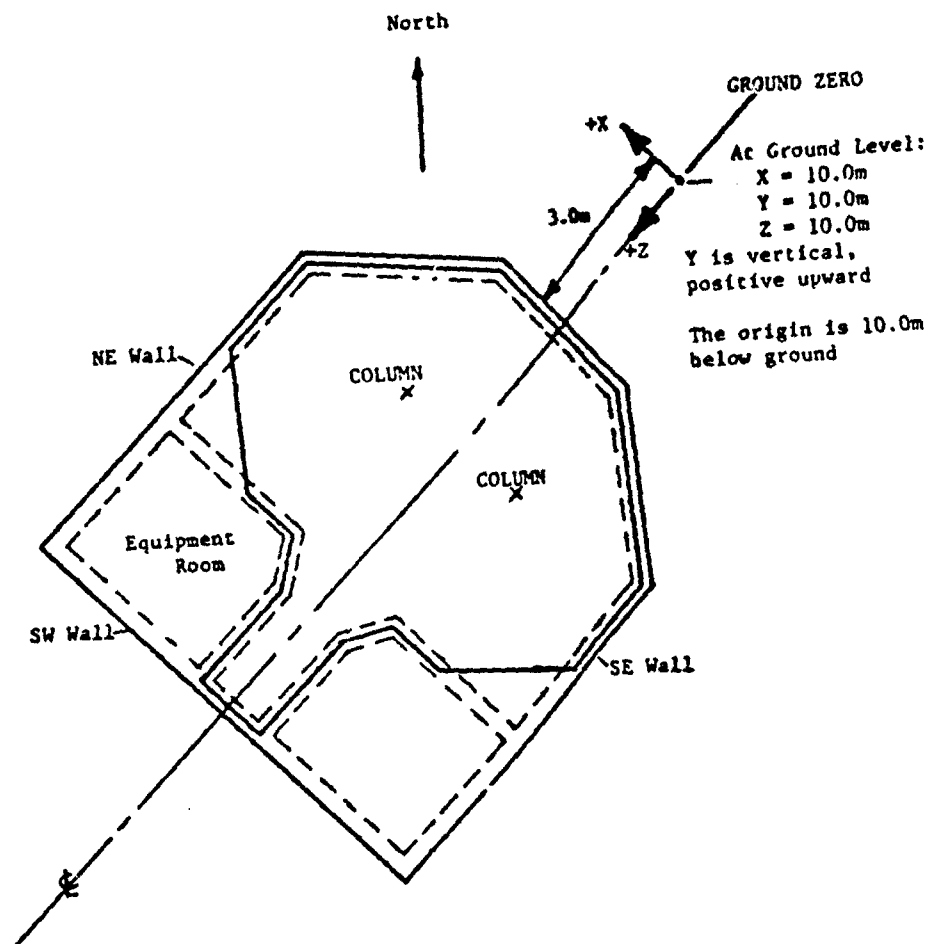


Figure G-1. Aircraft Shelter "D" Coordinate System

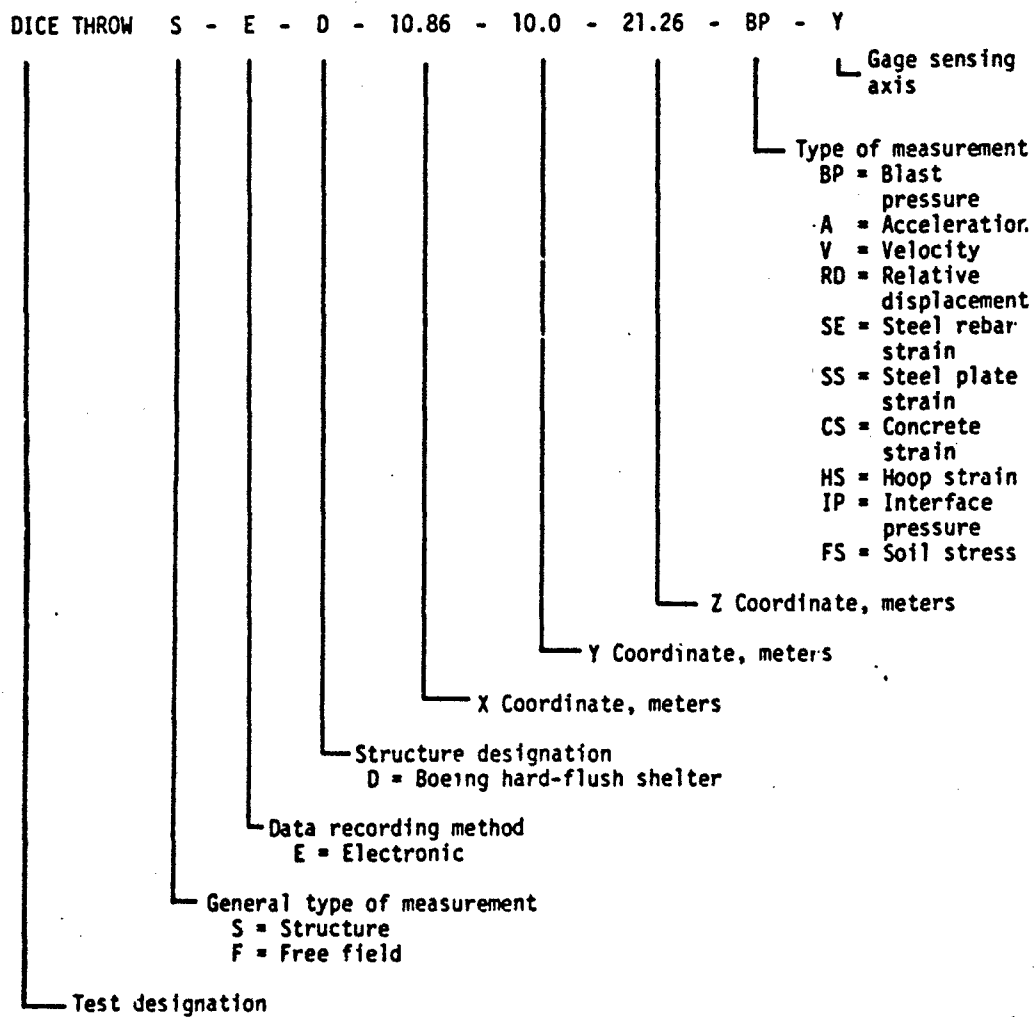


Figure G2. Measurement Designation System

DATA CORRECTIONS

DSP - points have been despiked.

SMT - a modified Hanning smooth has been performed.

FIL - a frequency cut-off or a band reject digital filter has been made.

BLC - the data has been baseline corrected.

INV - the polarity has been reversed.

On each page, the corrected plot is at the top and the uncorrected plot is at the bottom. Each acceleration plot is followed by its integral.

## DICE THROW, SHELTER G DATA CORRECTIONS

MEAS. NO.	COORDINATES			MEAS. TYPE	SENS. AXIS	DATA CORRECTIONS	GENERAL LOCATIONS
	X METERS	Y METERS	Z METERS				
47	10.97	9.43	18.71	BP	Z	DSP, SMT	Seal Leakage Top of Equip Room wall
48	13.81	9.43	16.87	BP	X	Scratched	Top NW Wall
49	9.72	9.43	13.25	BP	Z	Scratched	Top NE Wall
50	10.55	9.43	21.02	BP	X	DSP, SMT	Top SW Wall
51	10.00	7.59	16.51	BP	Y	DSP, SMT, FIL	Center of Floor
52	10.86	10.00	14.09	BP	Y	DSP, SMT	Overpressure NE End Shelter
53	10.86	10.00	21.26	BP	Y	DSP, SMT	SW End Shelter
113	10.00	9.63	13.45	A	Y	DSP, SMT, BLC	NE End Roof
114	10.00	8.85	13.25	A	Y	DSP, SMT	Top NE Wall
115	10.00	8.85	13.25	A	Z	DSP, SMT	Top NE Wall
116	11.65	9.10	18.73	A	Y	DSP, SMT	Equip NE Wall (Upper Level)
117	11.65	9.10	18.73	A	Z	DSP	Equip NE Wall (Upper Level)
118	12.30	8.63	19.95	A	Y	DSP	(Upper Level) Equip
119	12.30	8.63	19.95	A	Z	SMT, BLC	Rm Floor (Upper Level) Equip
120	13.45	9.63	15.70	A	Y	DSP	Rm Floor
121	13.65	9.63	15.70	A	Z	DSP, SMT, BLC	NE Actuator
122	10.00	9.70	10.00	A	Y	DSP, SMT	FF .3m Deep
123	10.00	9.70	10.00	A	Z	DSP, SMT, FIL, BLC	FF .3m Deep
124	10.00	7.60	24.59	A	Y	DSP, SMT, FIL, BLC	FF 2.4m Deep
125	10.00	7.60	24.59	A	Z	DSP, SMT	FF 2.4m Deep
126	10.00	9.70	24.59	A	Y	DSP, SMT, BLC	FF .3m Deep
127	10.00	9.70	24.59	A	Z	DSP, SMT, FIL	FF .3m Deep
128	10.00	7.60	10.00	A	Y	DSP, SMT, FIL	FF 2.4m Deep
129	10.00	7.60	10.00	A	Z	DSP, SMT, FIL	FF 2.4m Deep

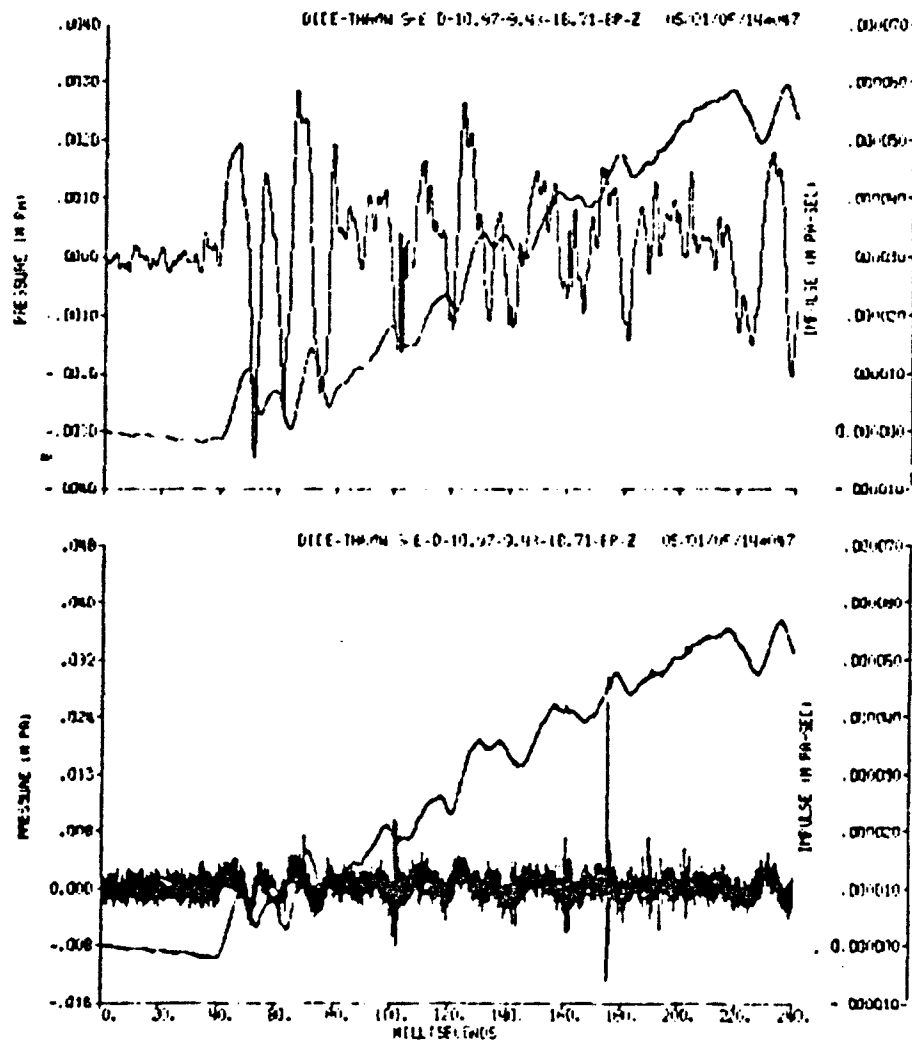
## DICE THROW, SHELTER D DATA CORRECTIONS (cont'd)

MEAS. NO.	COORDINATES			MEAS. TYPE	SERIS. AXIS	DATA CORRECTIONS	GENERAL LOCATIONS
	X METERS	Y METERS	Z METERS				
240	10.00	9.63	13.45	V	Y	DSP, SMT, BLC	NE End Roof
241	10.00	9.63	17.02	V	Y	DSP, SMT, BLC	Middle of Roof
242	10.00	9.43	13.25	V	Y	DSP, SMT, BLC	Top NE Wall
243	10.00	9.43	13.25	V	Z	DSP, SMT, BLC	Top NE Wall
246	10.00	7.39	16.86	V	Y	DSP, SMT, BLC	Mid Foundation
247	10.00	7.39	16.86	V	Z	DSP, SMT	Mid Foundation
248	11.65	9.10	18.73	V	Y	DSP, SMT, BLC	Equip NE Wall (Up Level)
249	11.65	9.10	18.73	V	Z	DSP, SMT, BLC	Equip NE Wall (Up Level)
250	12.30	8.43	19.95	V	Y	DSP, SMT	Equip Rear Floor
251	12.30	8.43	19.95	V	Z	DSP, SMT, BLC	Equip Rear Floor
252	10.00	9.70	10.00	V	Y	DSP, SMT, BLC	FF .3m Deep
253	10.00	9.70	10.00	V	Z	DSP, SMT, BLC	FF .3m Deep
254	10.00	7.60	24.59	V	Y	DSP, SMT, BLC	FF 2.4 Deep
255	10.00	7.60	24.59	V	Z	DSP, SMT, BLC	FF 2.4 Deep
256	10.00	9.70	24.59	V	Y	DSP, SMT, BLC	FF .3 Deep
257	10.00	9.70	24.59	V	Z	DSP, SMT, FIL, BLC	FF .3 Deep
258	10.00	7.60	10.00	V	Y	DSP, SMT, BLC	FF 2.4 Deep
259	10.00	7.60	10.00	V	Z	DSP, SMT, BLC	FF 2.4 Deep
517	10.00	9.16	13.02	SE	X	DSP, SMT	Top NE Wall
518	10.00	9.00	13.23	SE	X	DSP, SMT	Top NE Wall
519	10.00	7.48	13.23	SE	Y	DSP, SMT	Bottom NE Wall
520	10.00	7.48	13.02	SE	Y	Scratched	Bottom NE Wall
521	10.83	9.98	15.91	SE	Z	DSP, SMT	Roof Above NW Column
522	11.00	9.98	15.81	SE	Z	DSP, SMT, FIL	Roof Above NW Column
523	9.87	9.63	17.02	SS	Z	DSP	Mid Roof
524	9.87	9.63	17.02	SS	X	DSP, SMT	Mid Roof
525	11.27	9.26	15.70	SS	Y	DSP, SMT	Top NW Column
526	11.27	7.94	15.70	SS	Y	DSP, SMT	Bot NW Column

## DICE THROW, SHELTER D DATA CORRECTIONS (cont'd)

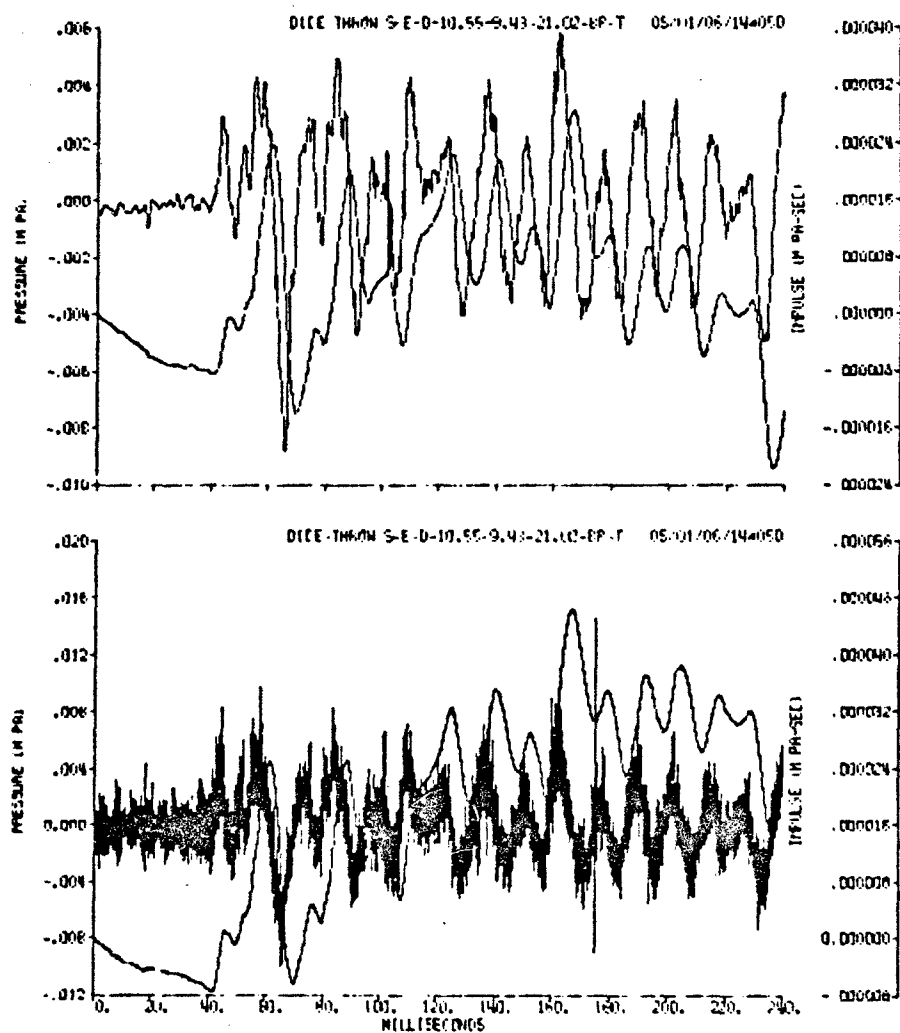
## COORDINATES

MEAS. NO.	X METERS	Y METERS	Z METERS	MEAS. TYPE	SENS. AXIS	DATA CORRECTIONS	GENERAL LOCATIONS
527	11.41	9.24	18.64	CS	Y	DSP, SMT - Concrete Strain	NE Wall Equip Rm.
528	10.00	7.38	16.86	SE	Z	DSP, SMT	Concrete Strain
529	10.00	7.38	16.86	SE	X	DSP, SMT	Mid Foundation
530	11.35	9.22	18.43	SE	Y	DSP, SMT, FIL	Mid Foundation
531	10.00	9.22	13.35	SE	Y	DSP, SMT	NE Equip Rm Roof Tie Down
532	13.71	9.22	15.42	SE	Y	DSP, SMT	NE Wall Roof Tie Down
533	10.00	9.22	21.29	SE	Y	DSP, SMT	NW Wall Roof Tie Down
534	11.22	9.22	13.35	SE	Y	DSP, SMT, FIL	SW Wall Roof Tie Down
535	6.29	9.22	15.42	SE	Y	DSP, SMT, FIL	NE Wall Roof Tie Down
536	11.38	8.70	13.24	SE	X	DSP, SMT, FIL	SE Wall Roof Tie Down
537	11.38	8.70	13.17	SE	X	DSP, SMT	Top NE Wall North Corner
538	8.61	8.73	13.24	SE	X	DSP, SMT	Top of NE Wall North Corner
539	8.61	8.73	13.17	SE	X	DSP, SMT, FIL	Top of NE Wall East Corner
540	8.73	9.26	15.70	SS	Y	DSP, SMT, FIL	Top of NE Wall East Corner
541	12.61	8.66	14.19	SS	X	Scatched	Top of SE Corner
554	10.07	9.06	13.00	IP	Z	DSP, SMT	Top of North Wall
555	10.15	9.11	13.00	IP	Z	DSP, SMT	Top NE Wall Outside
556	10.00	7.6	13.00	FS	Z	DSP, SMT	Center of NE Wall (Outside)
557	10.00	7.26	13.46	FS	Y	DSP, SMT	Bottom of NE Wall (Outside)
558	8.33	7.26	15.81	FS	Y	DSP	Under NE Wall
559	10.00	7.26	16.91	FS	Y	DSP	Under South Column Footing
560	12.77	8.15	14.09	IP	Z	SMT	Under Center of Building
561	14.06	8.14	16.06	IP	X	DSP, SMT	Center of North Wall (Outside)
562	5.94	8.10	16.07	IP	X	DSP, SMT	Center of NW Wall (Outside)
							Center of SE Wall (Outside)

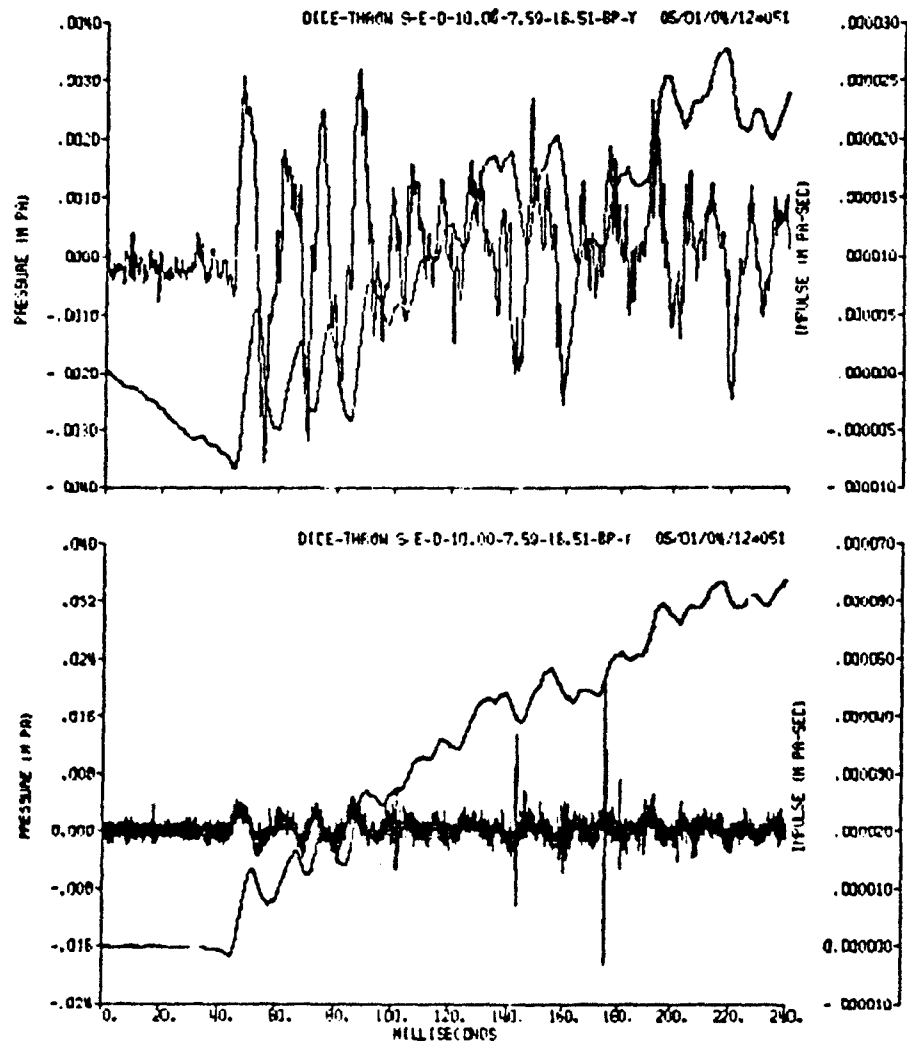


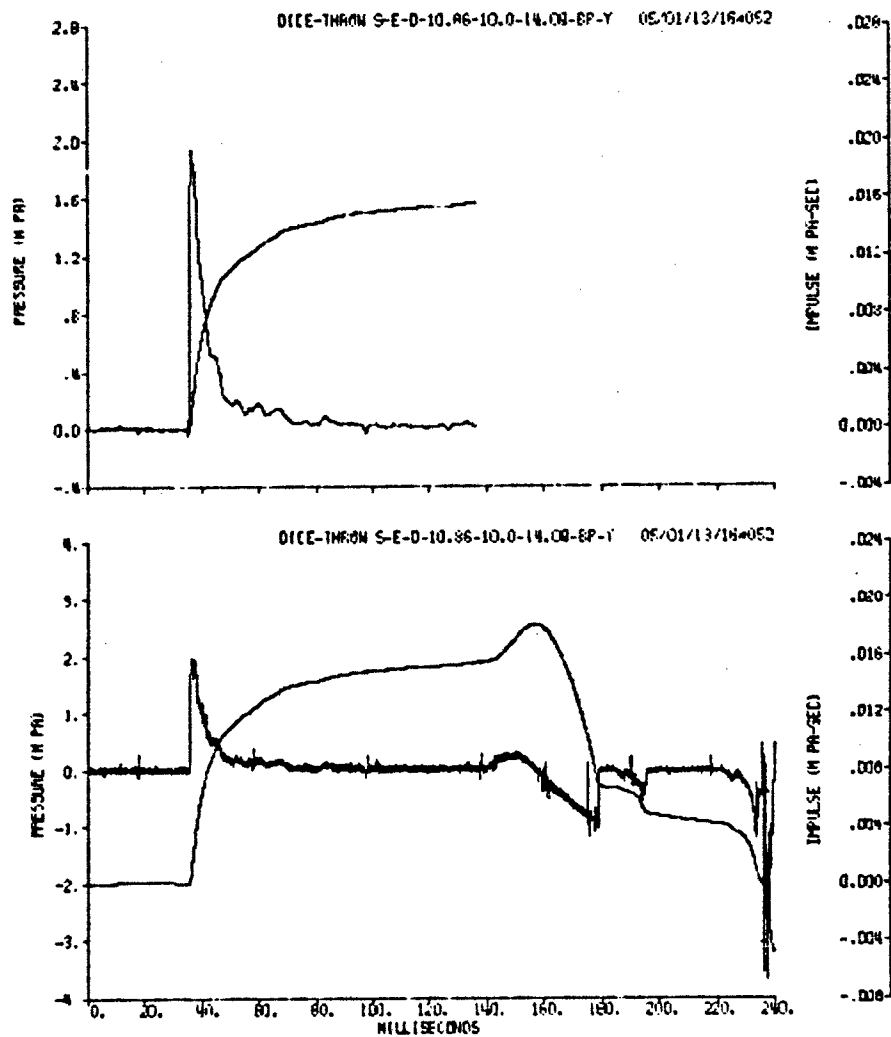


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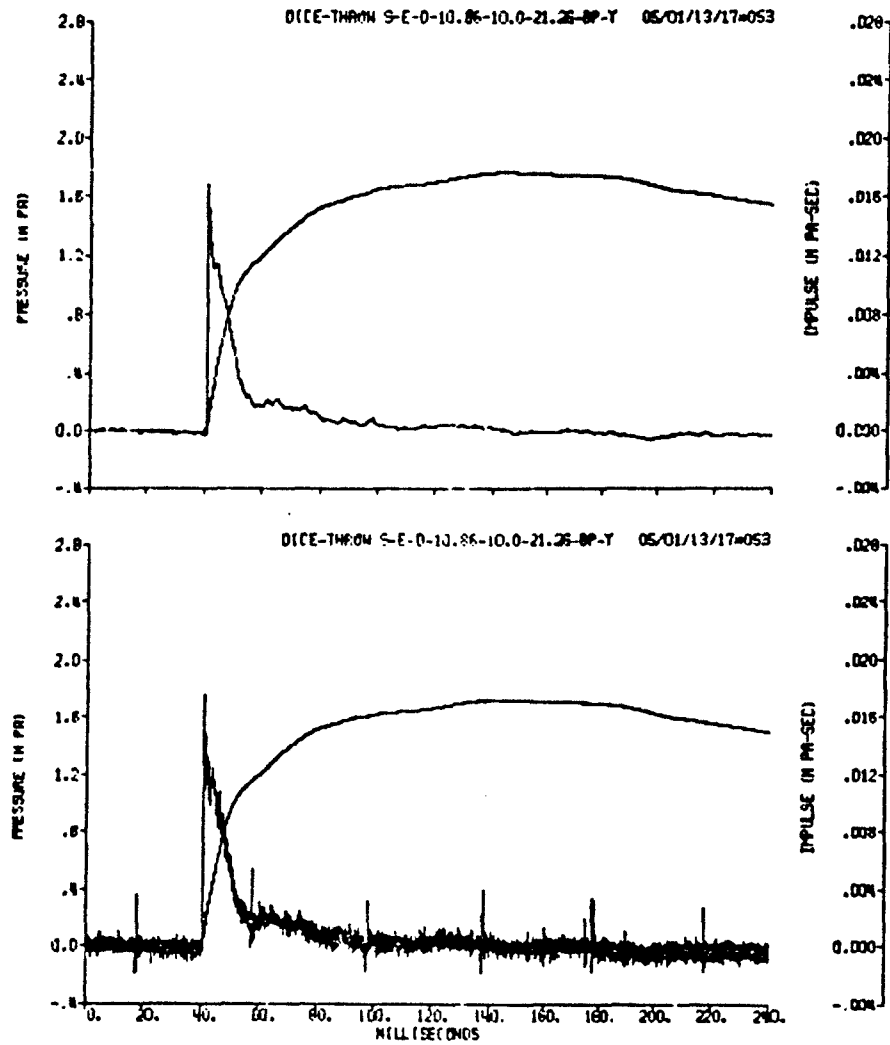


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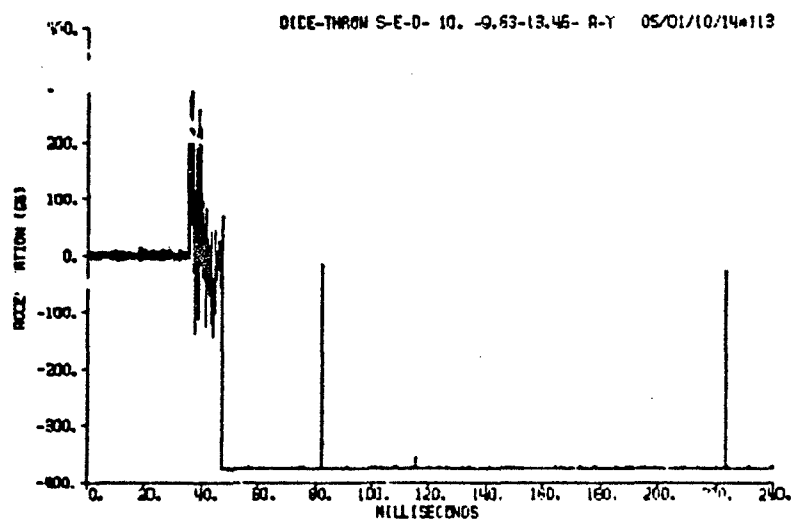
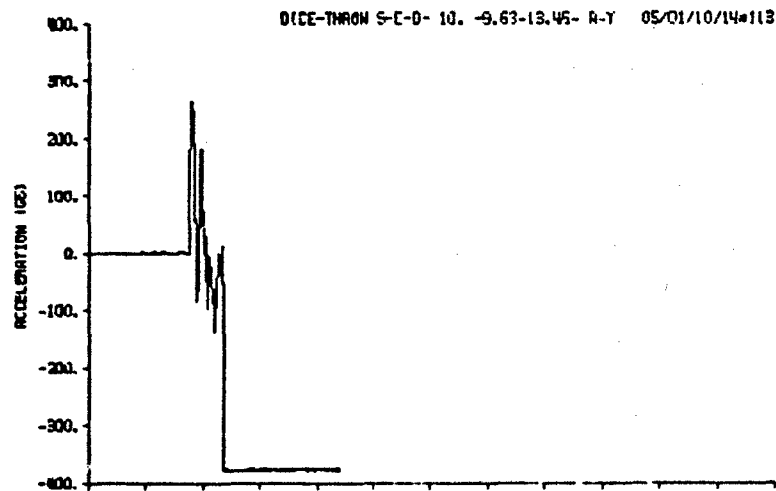


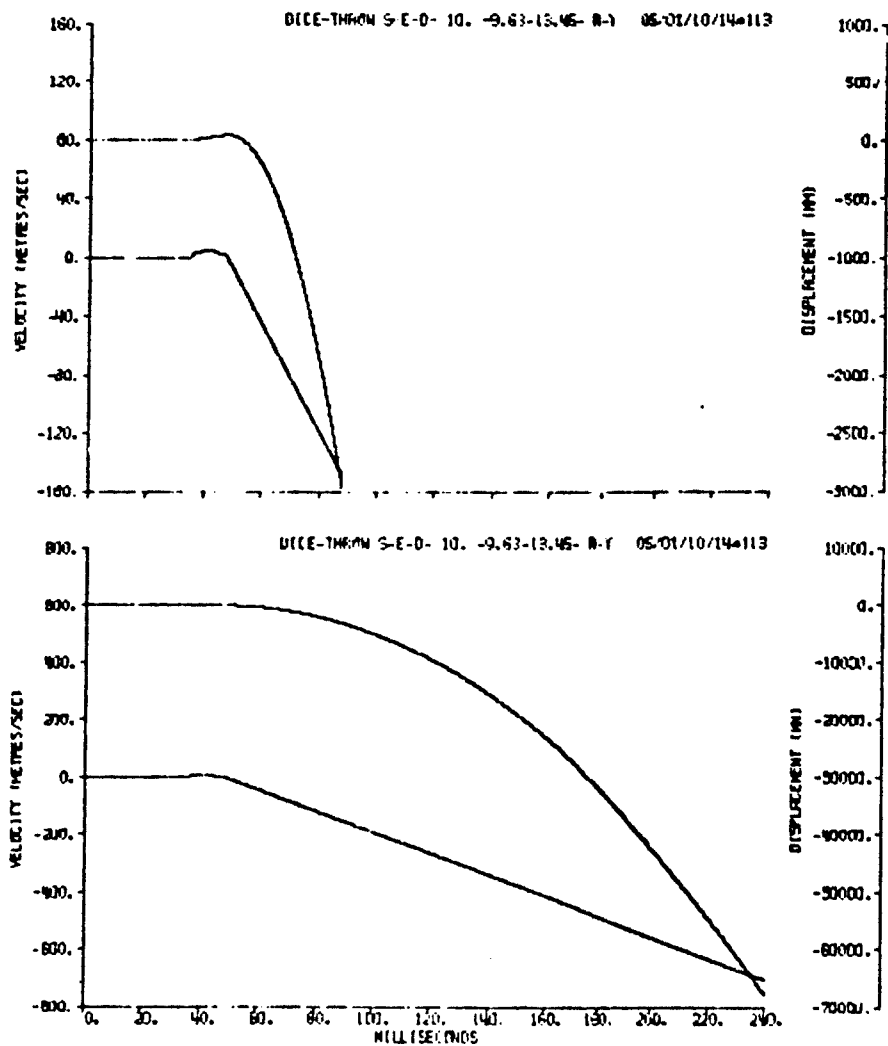


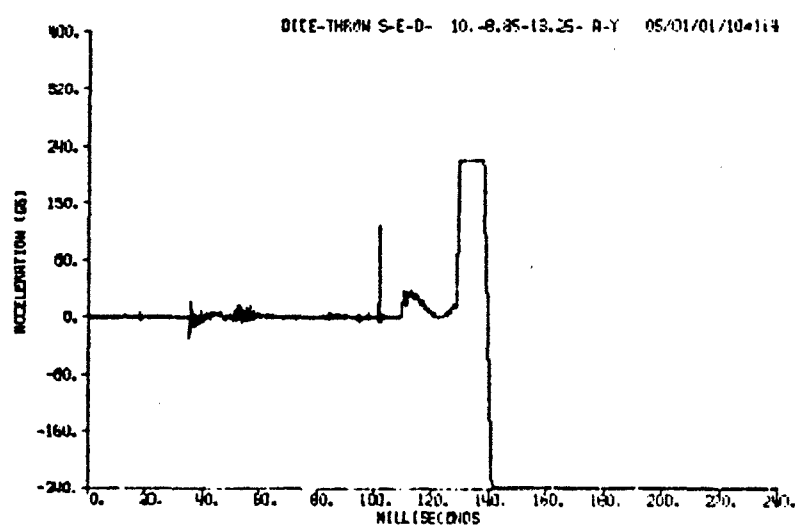
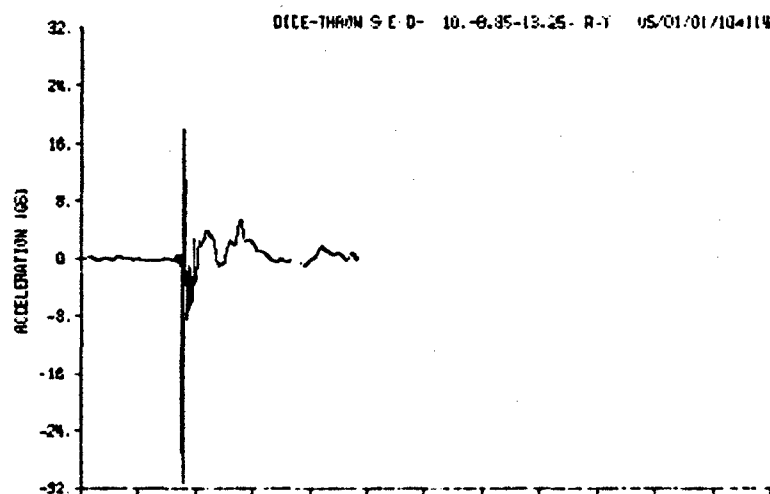
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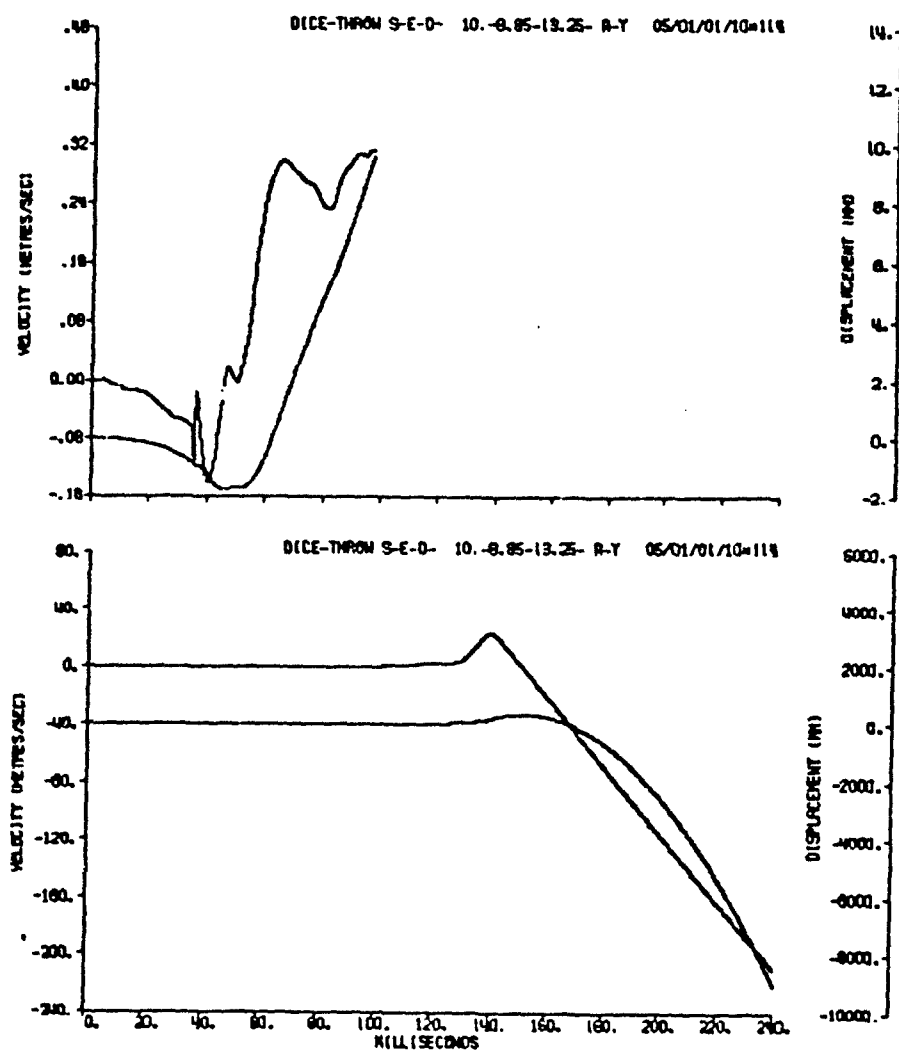


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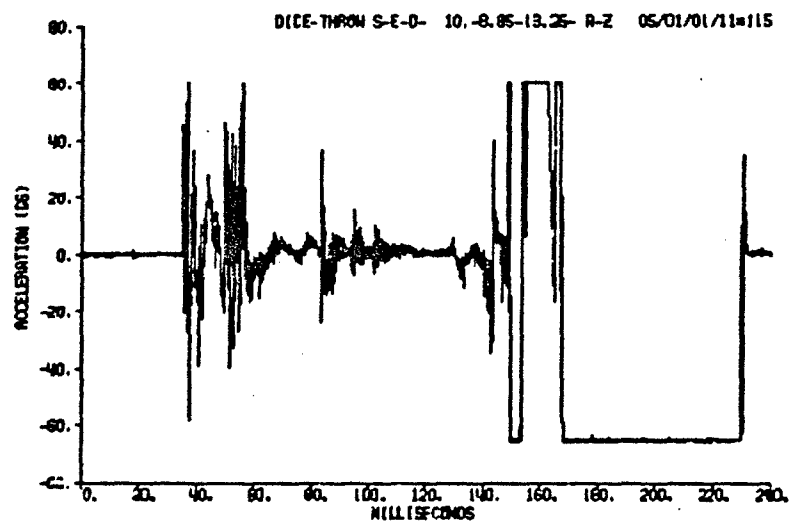
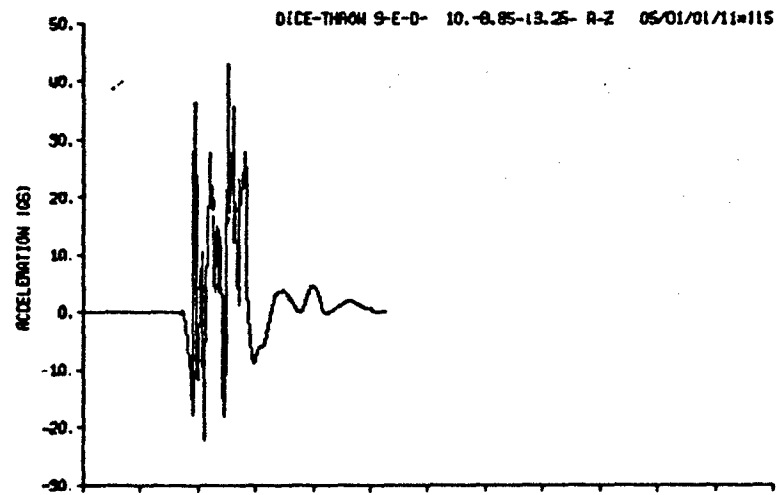


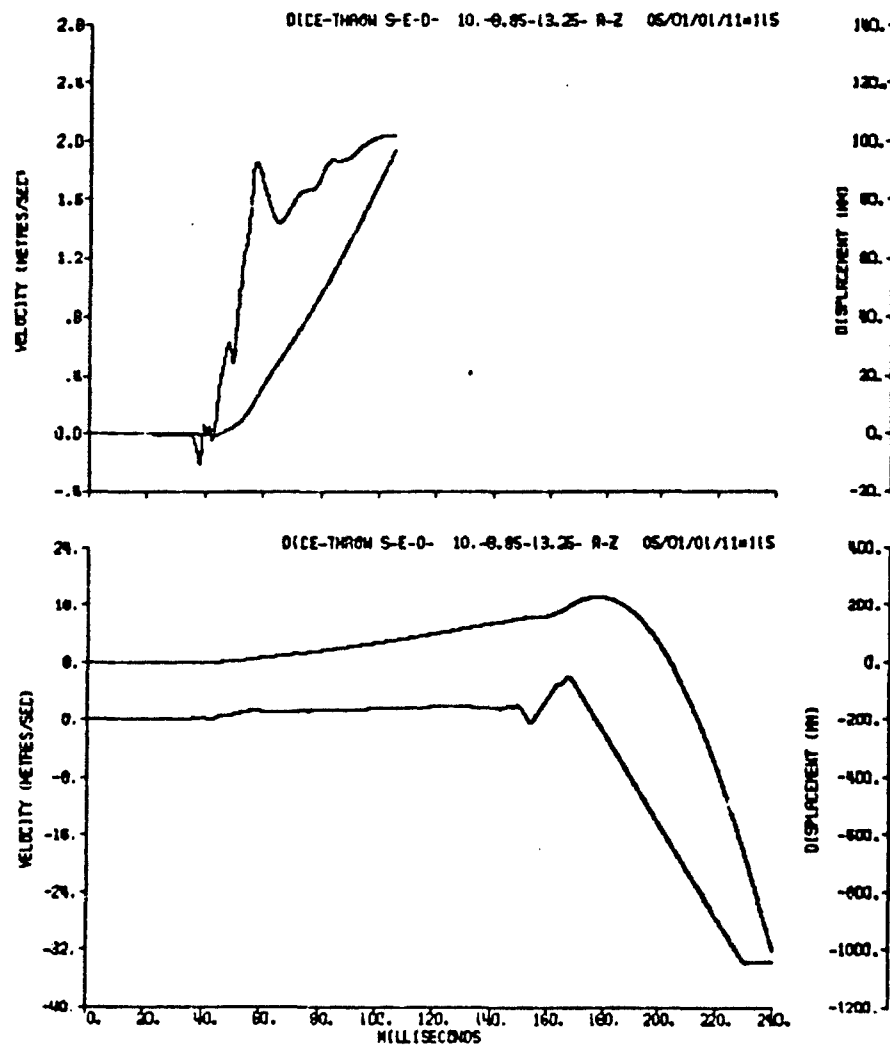


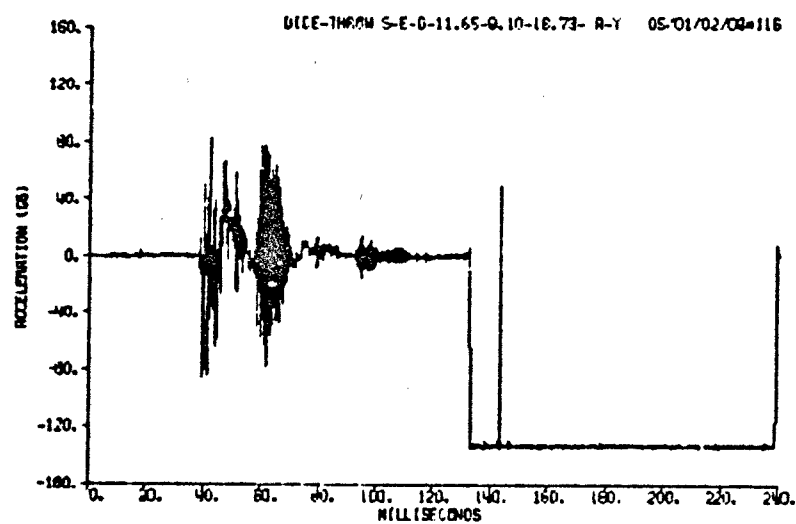
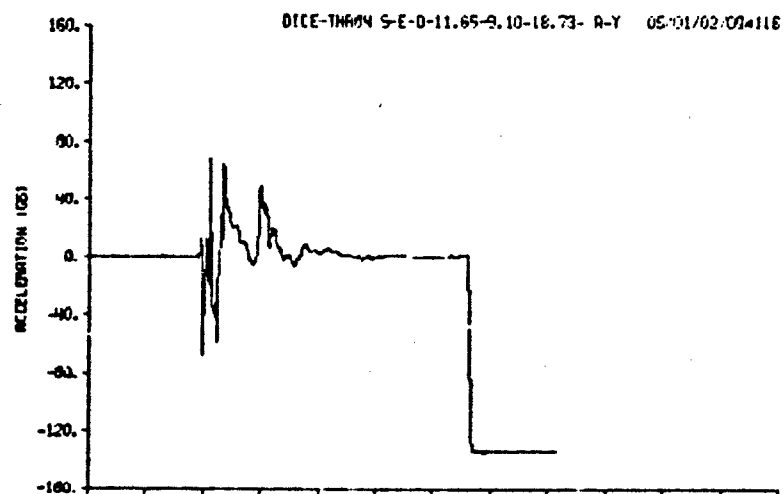


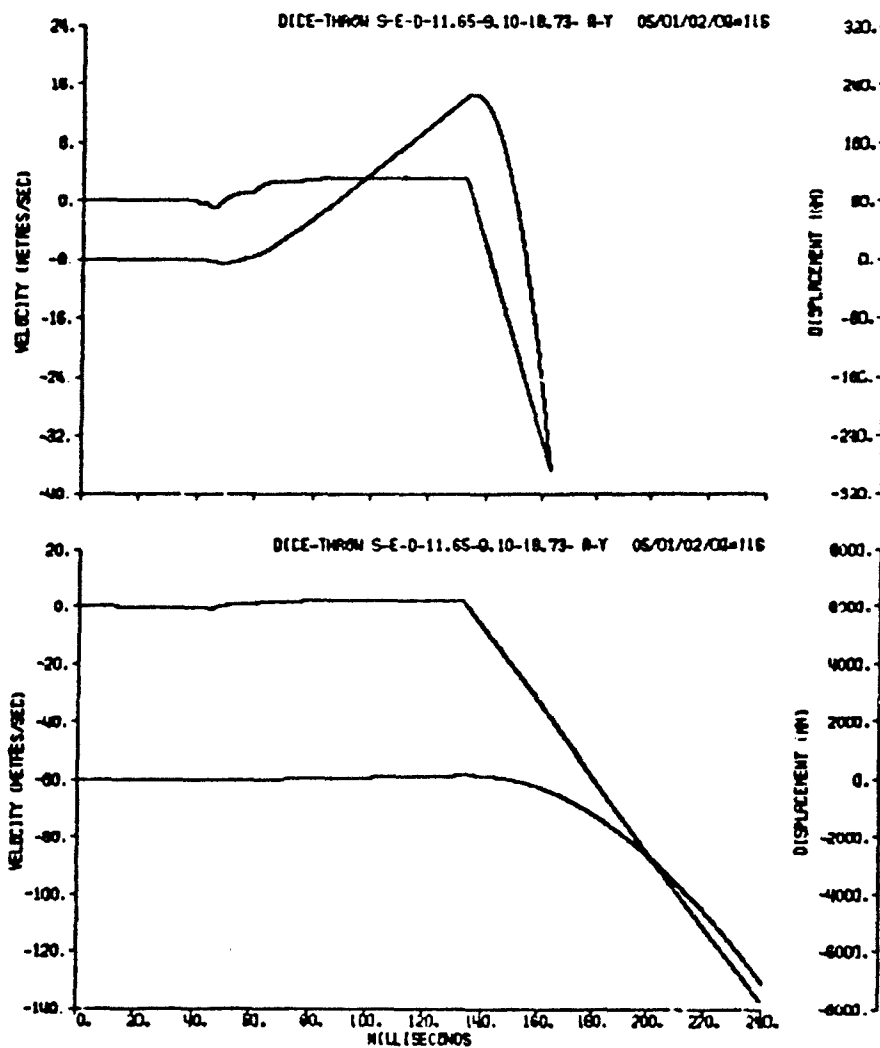


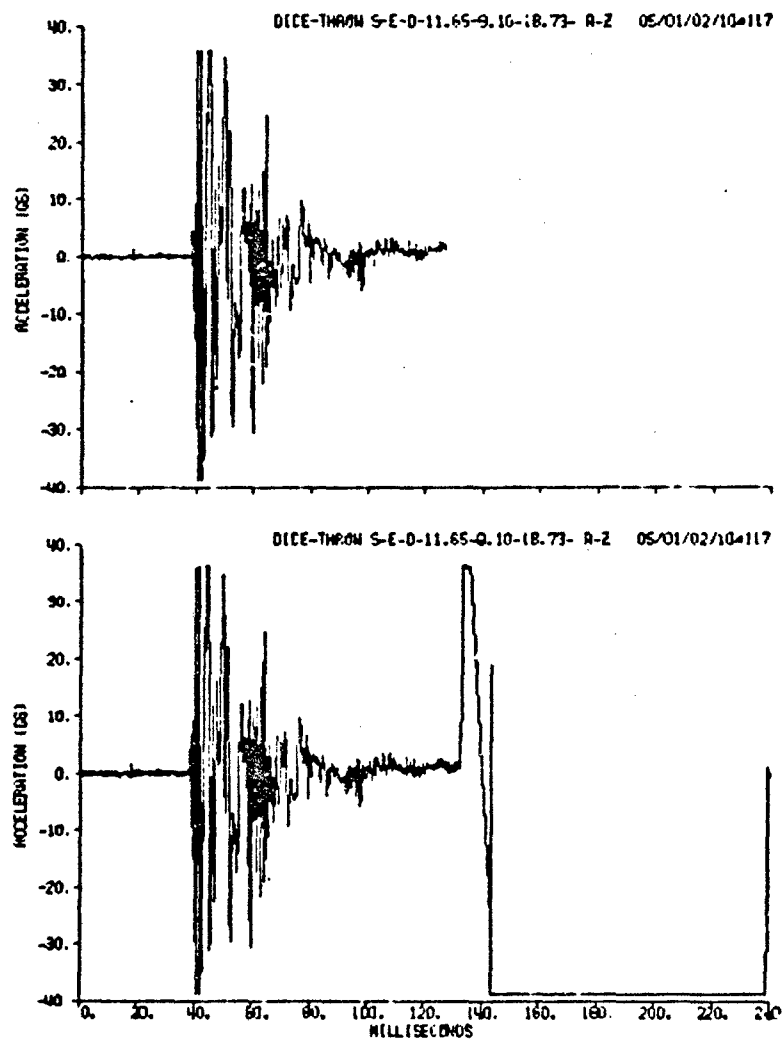


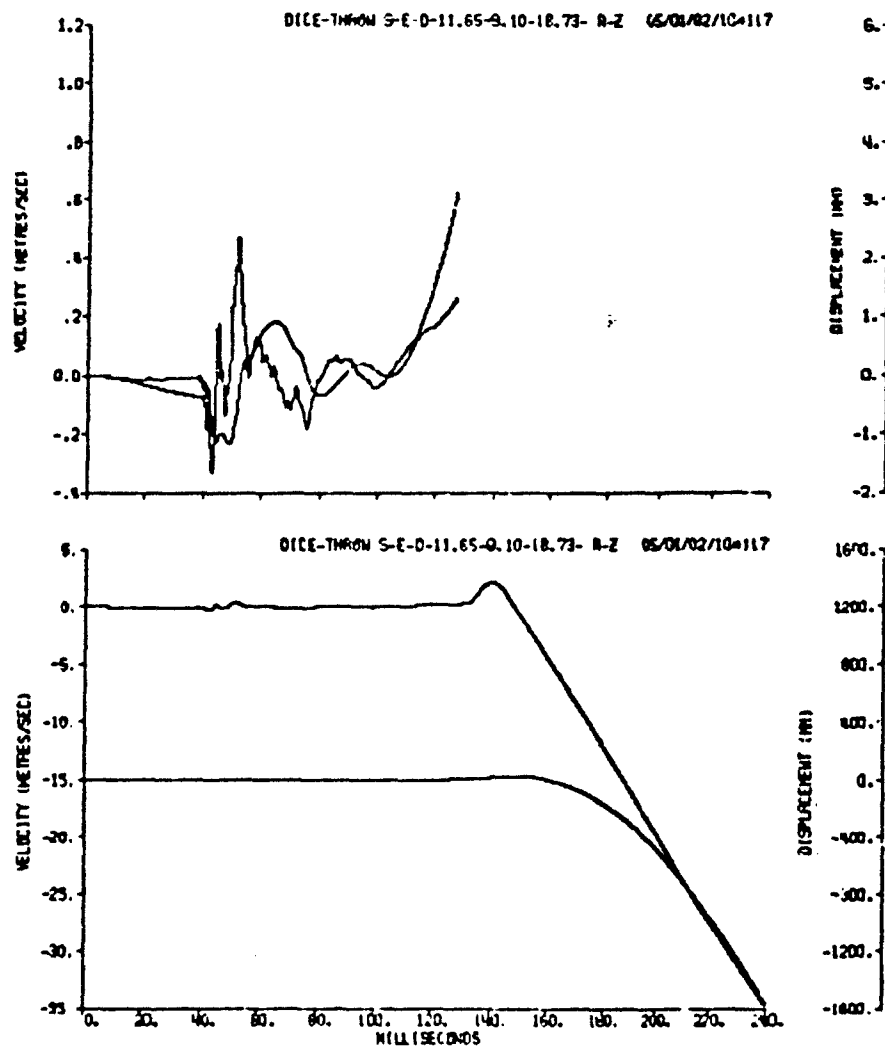




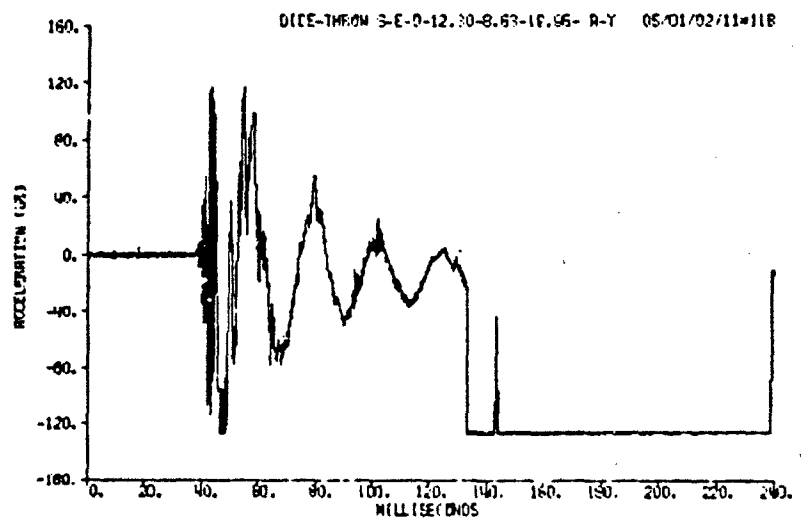
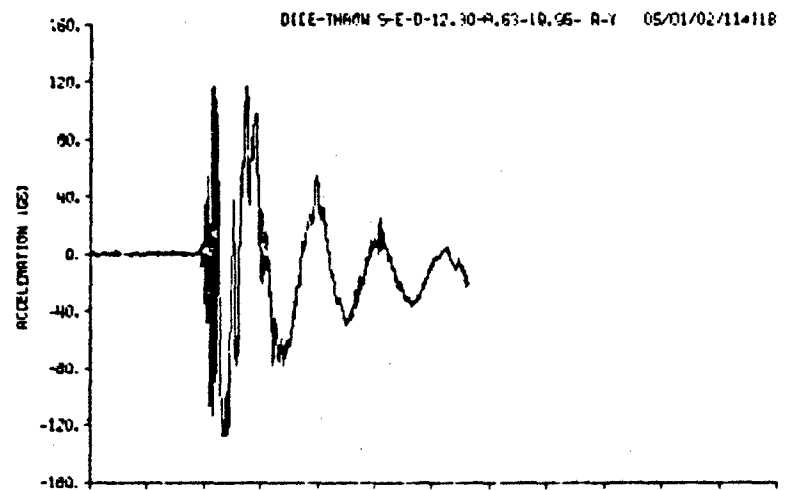


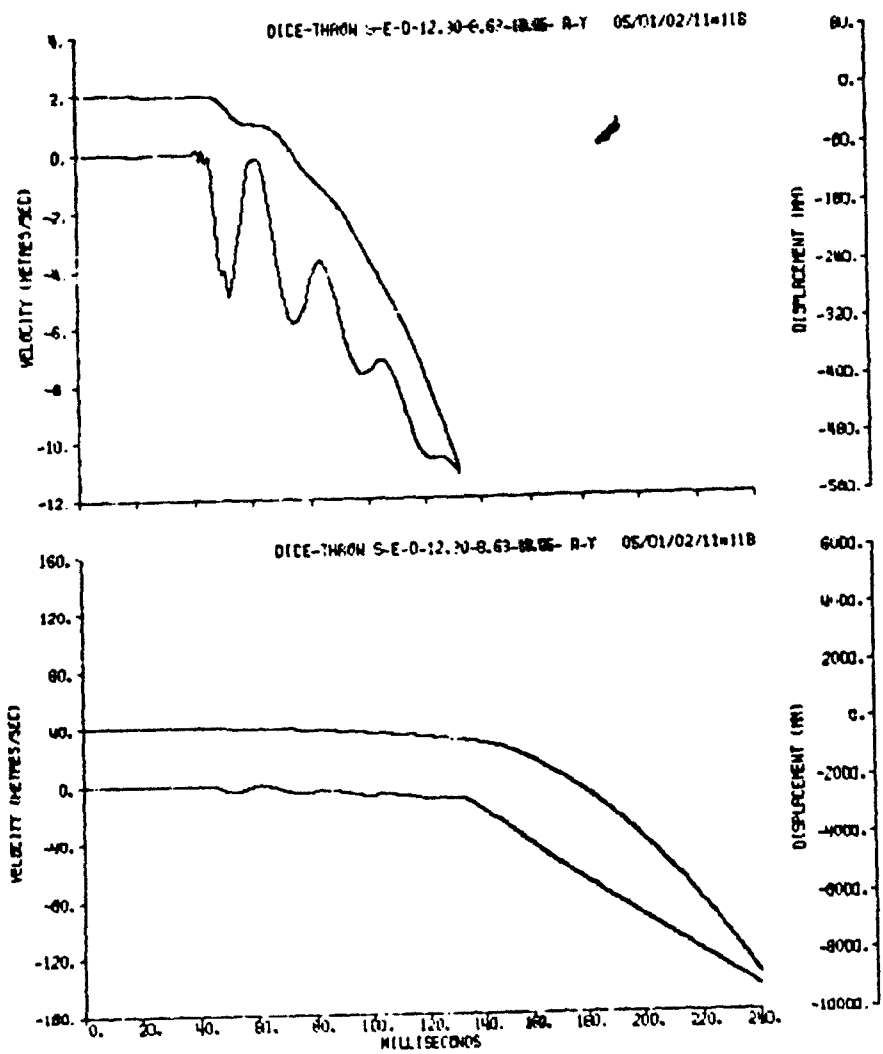






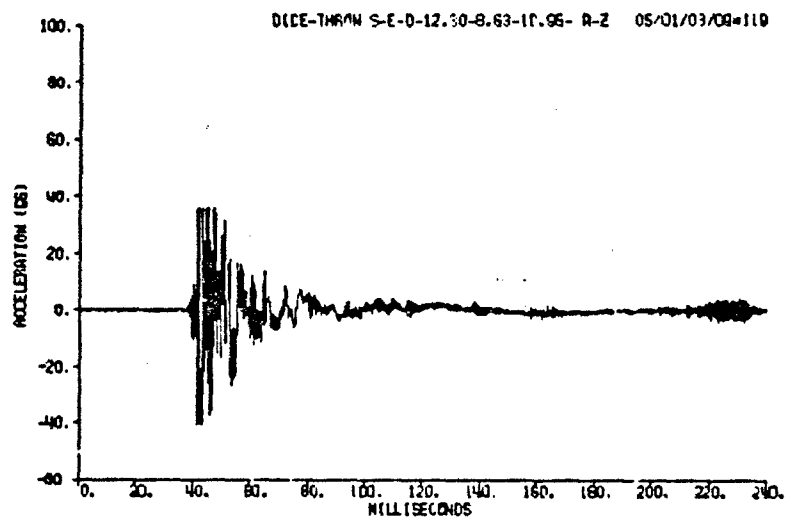
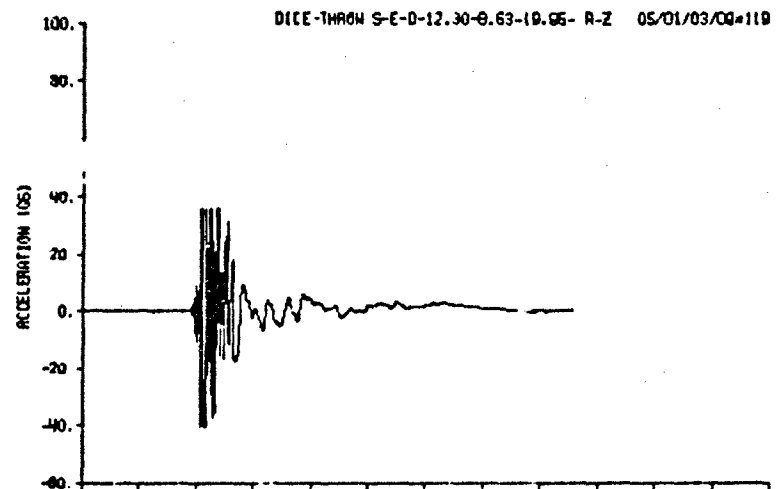
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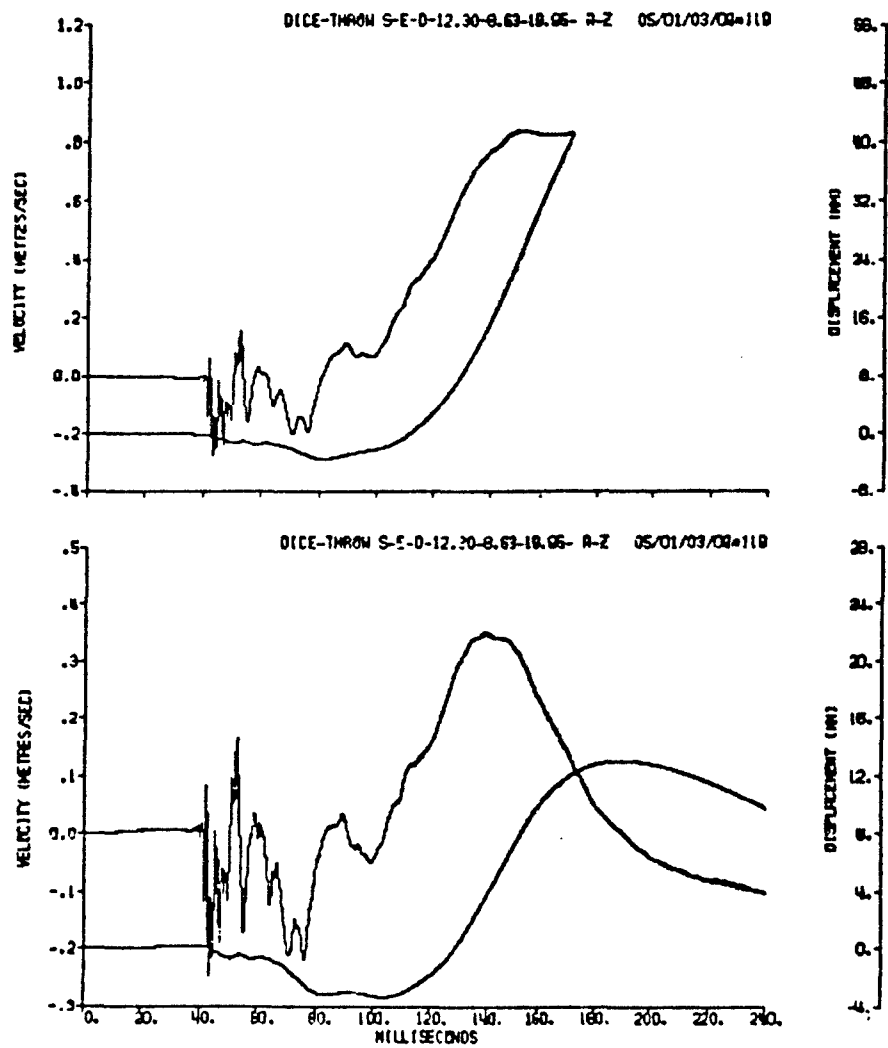




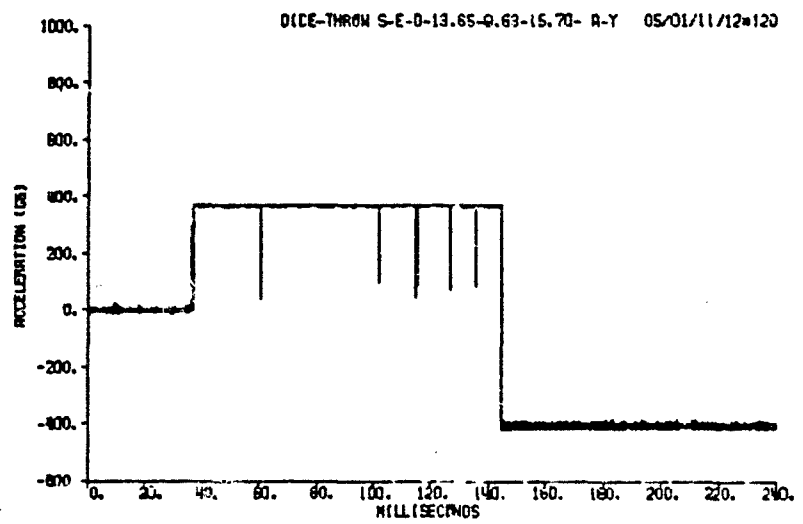
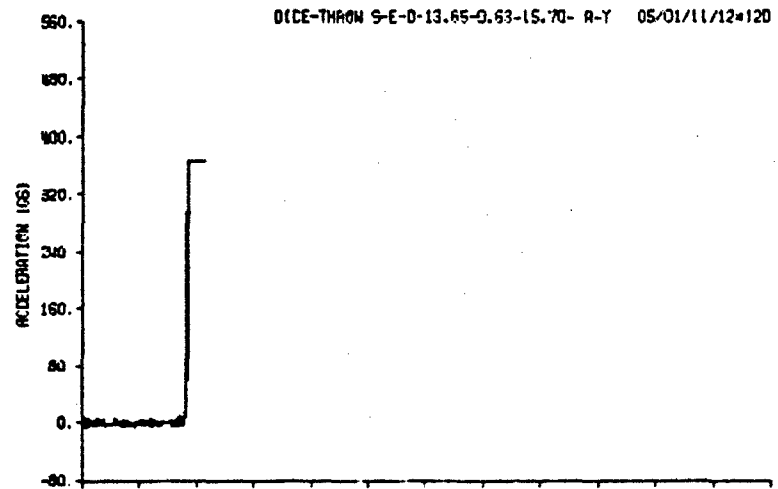


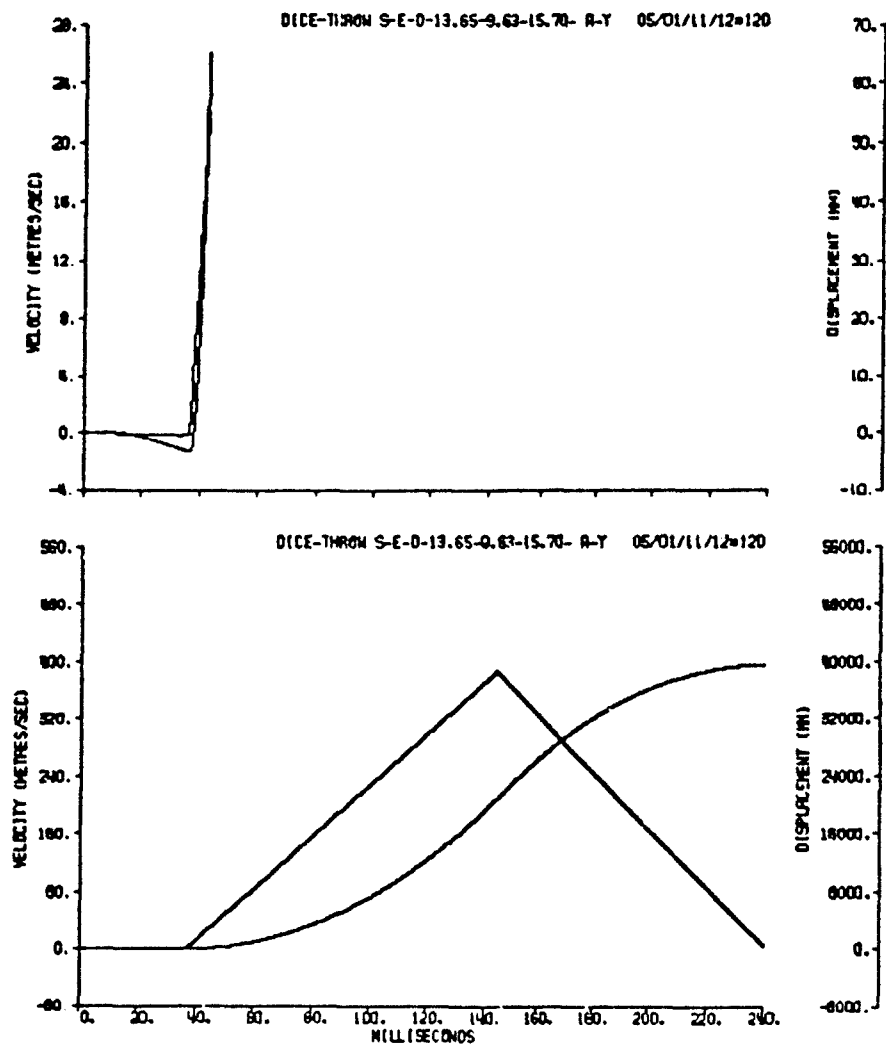
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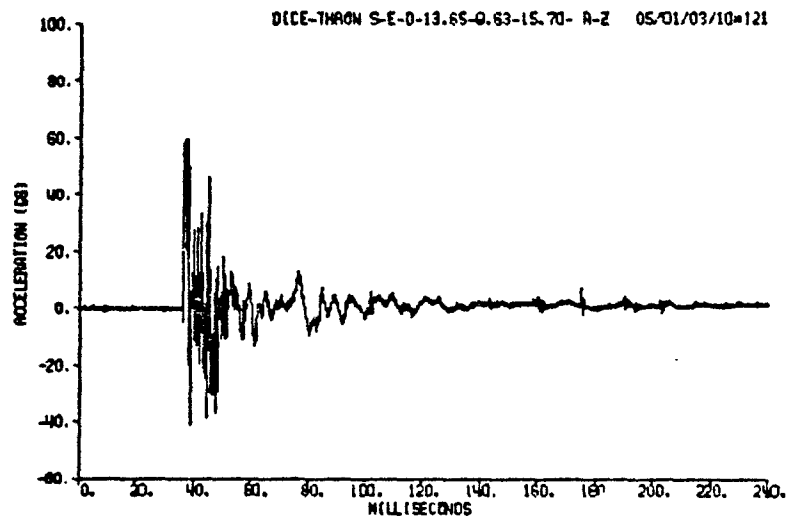
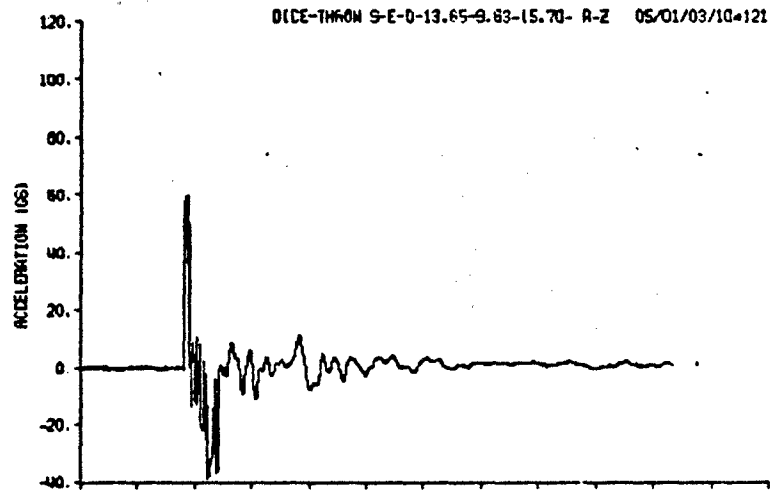


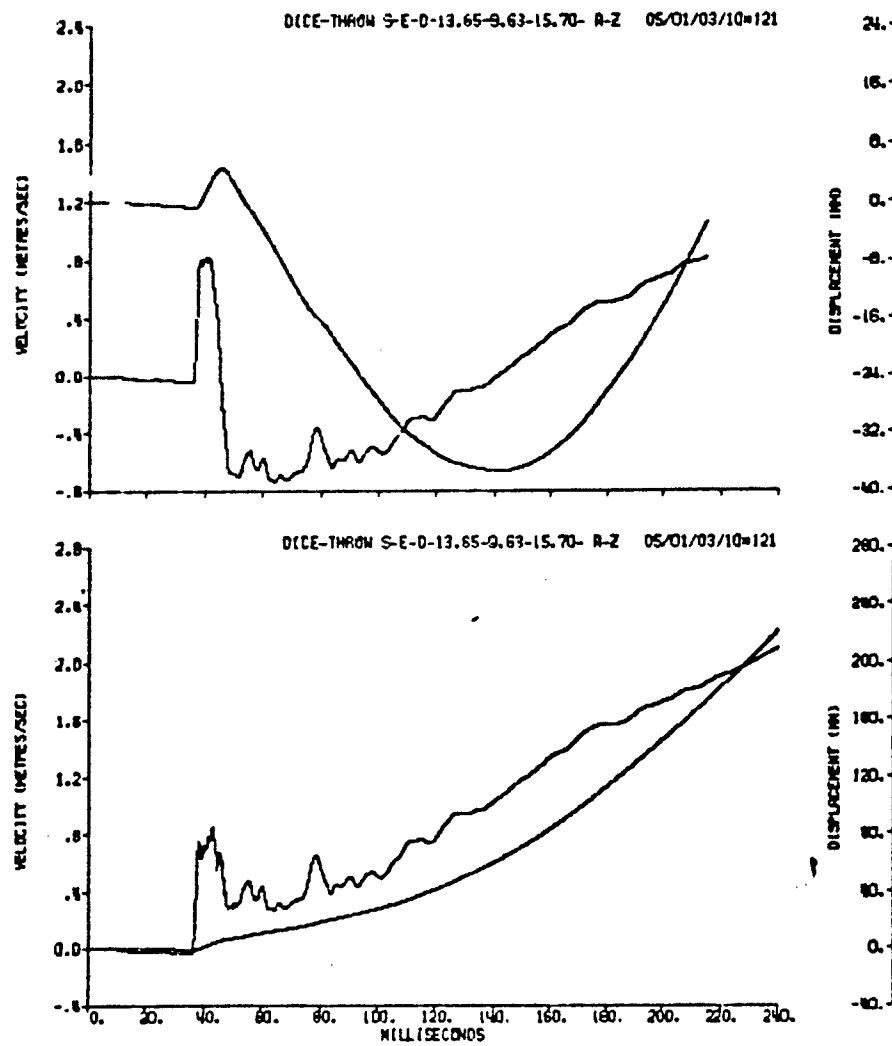
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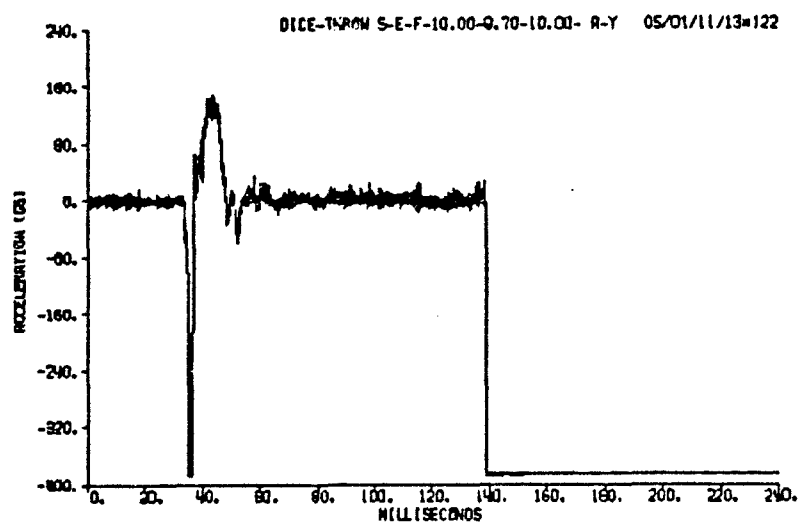
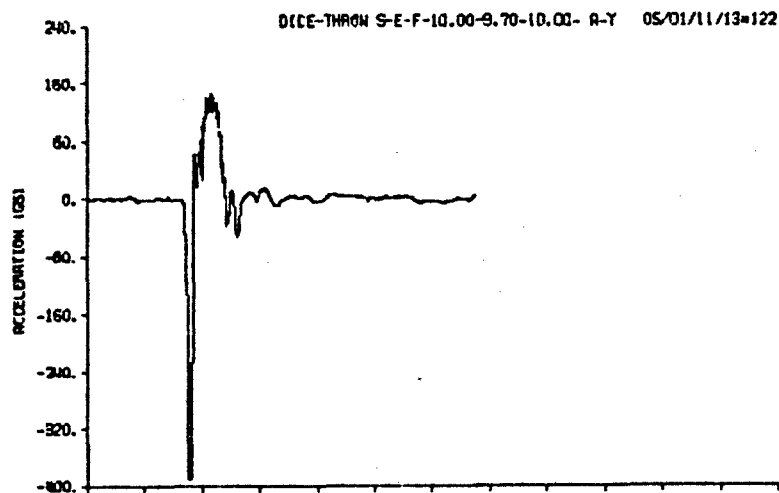


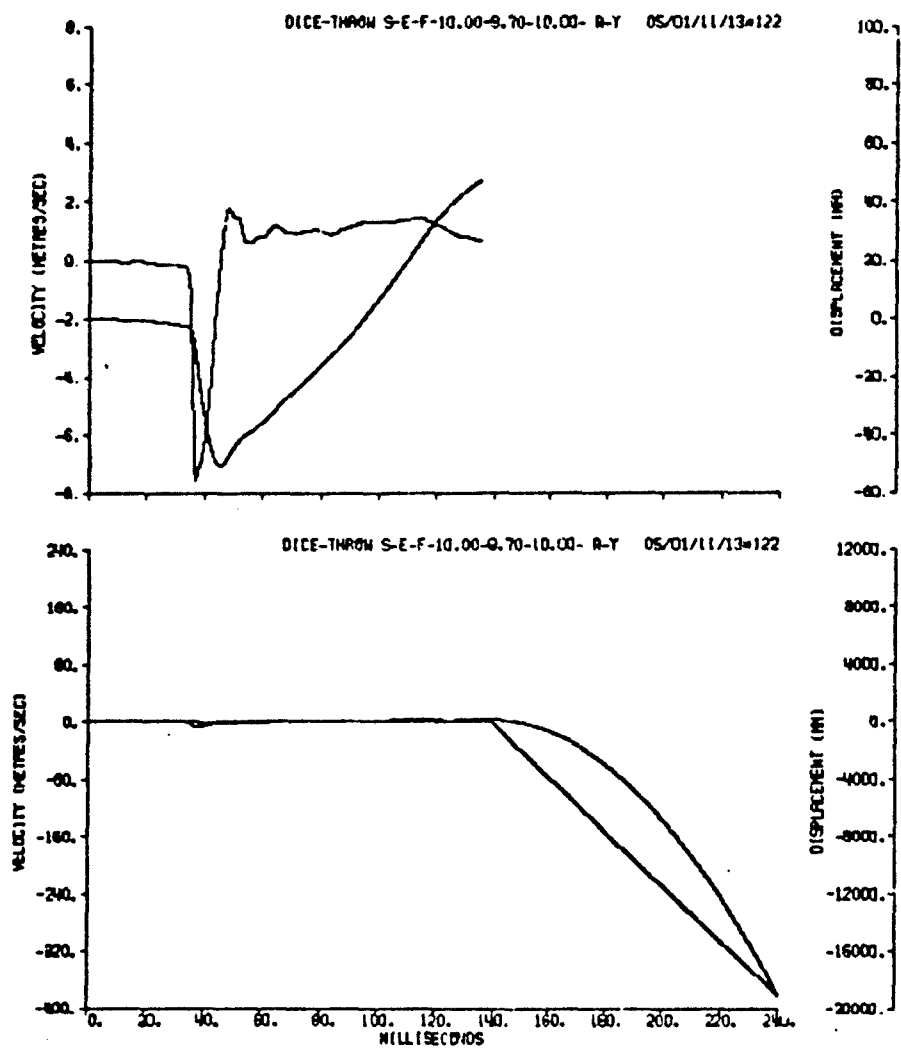
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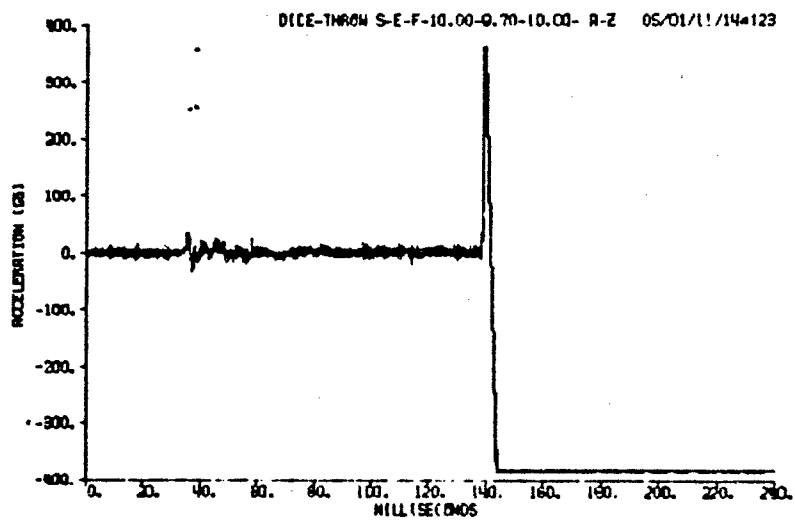
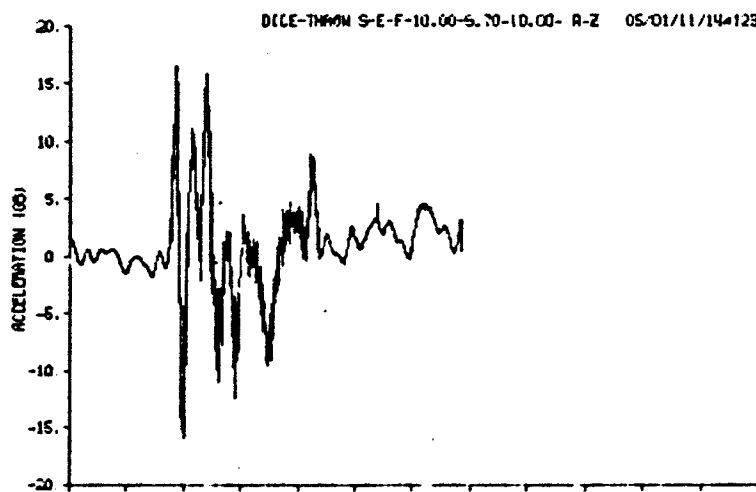


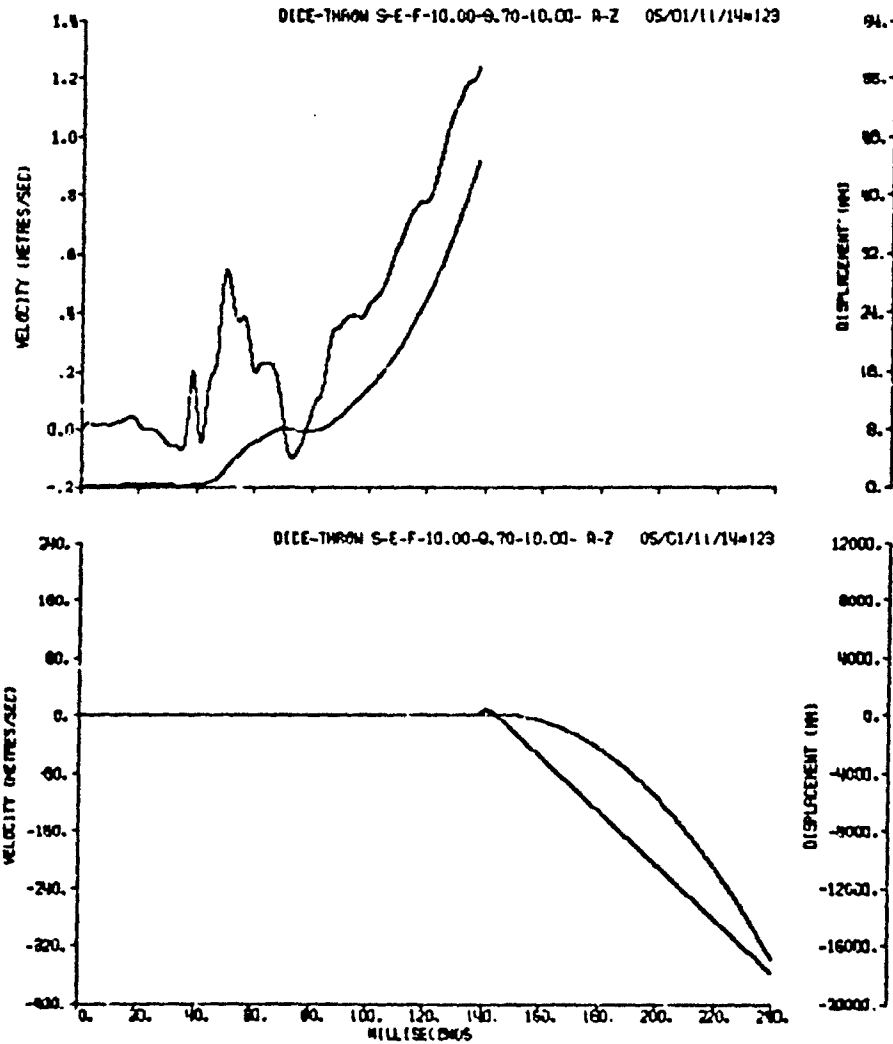
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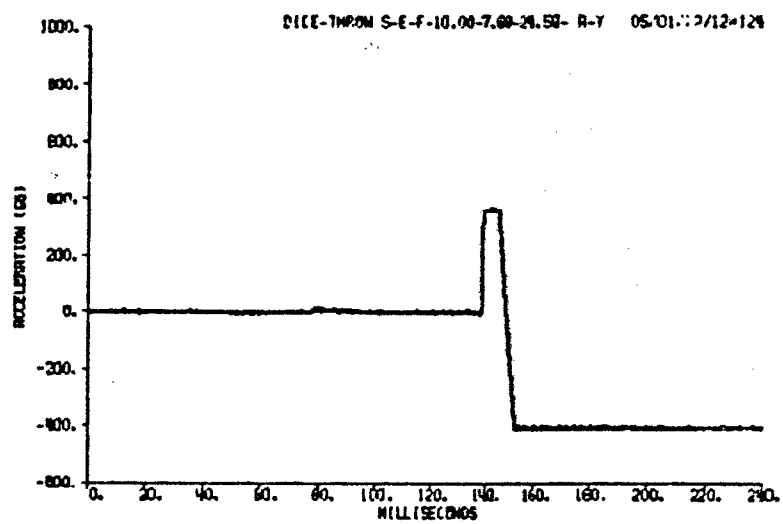
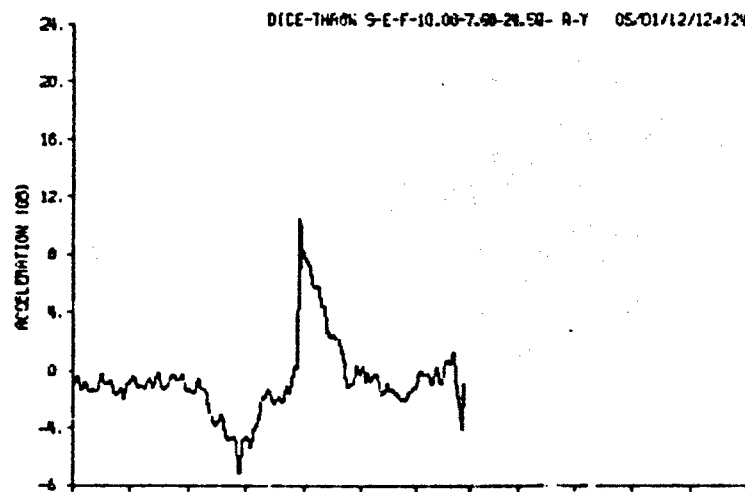


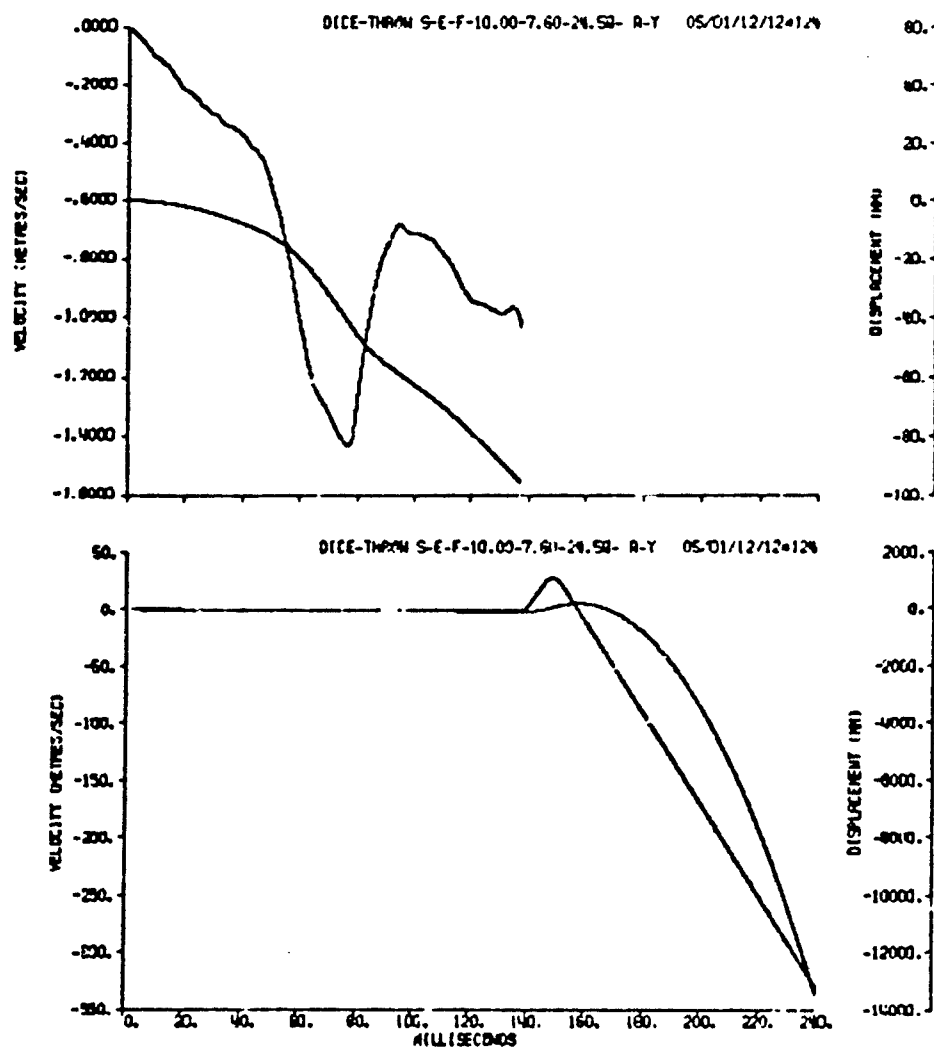




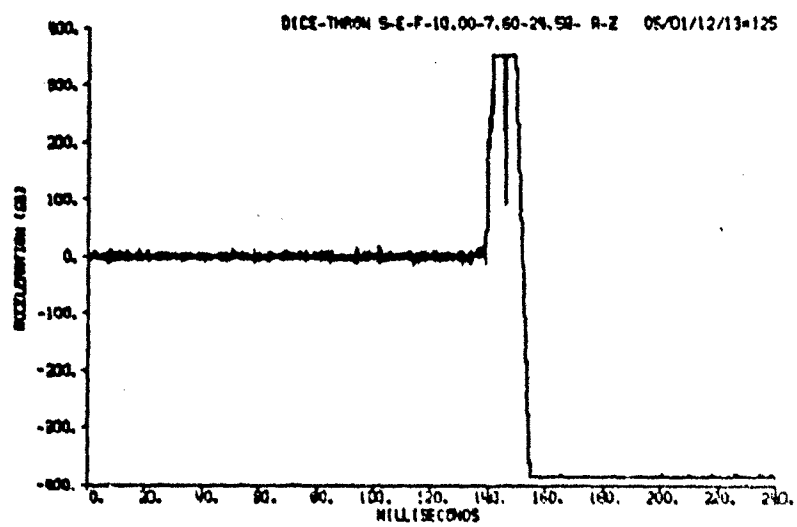
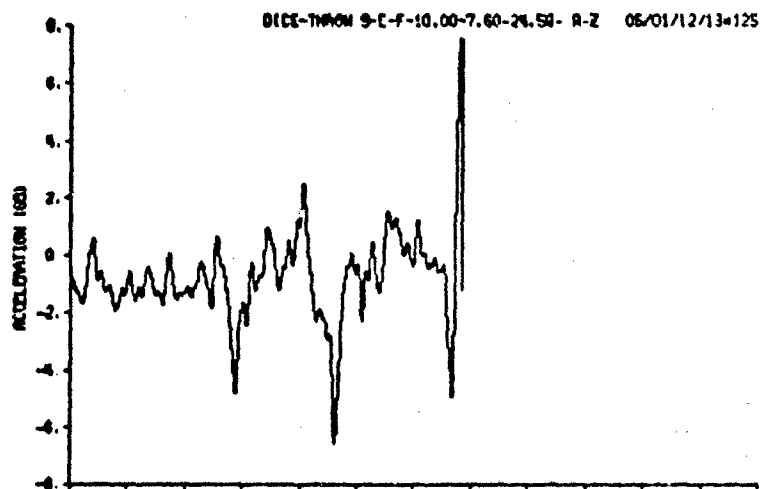




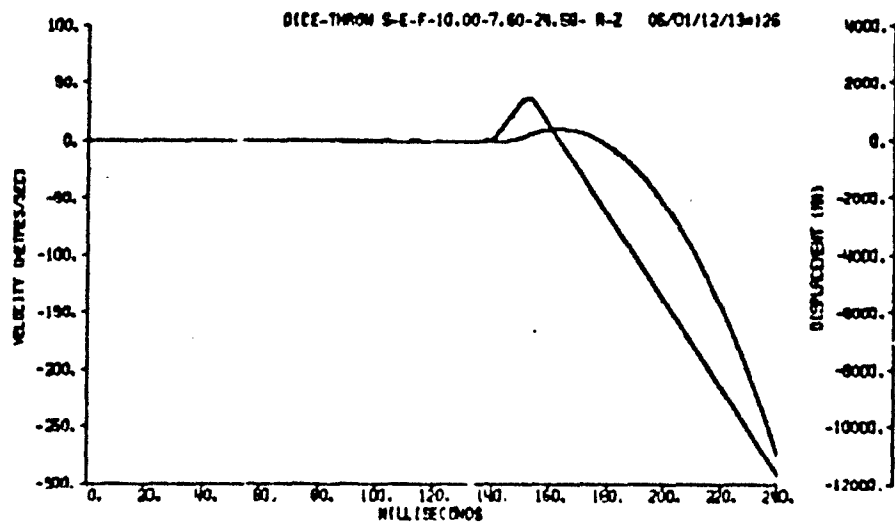
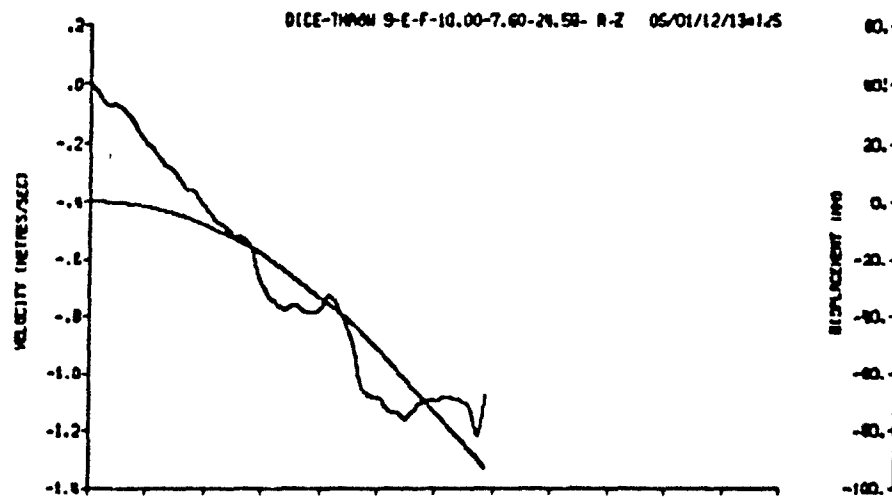




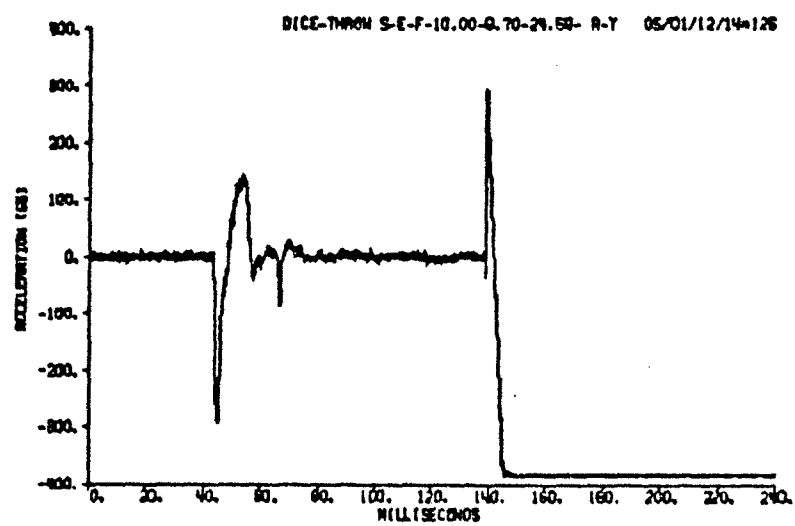
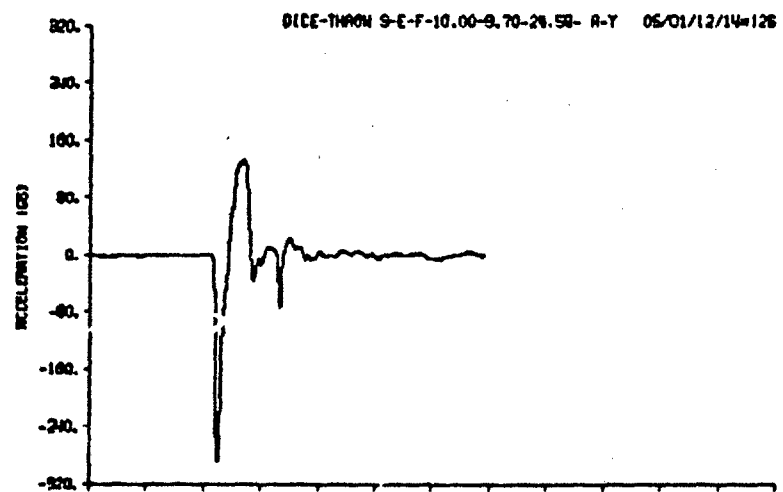
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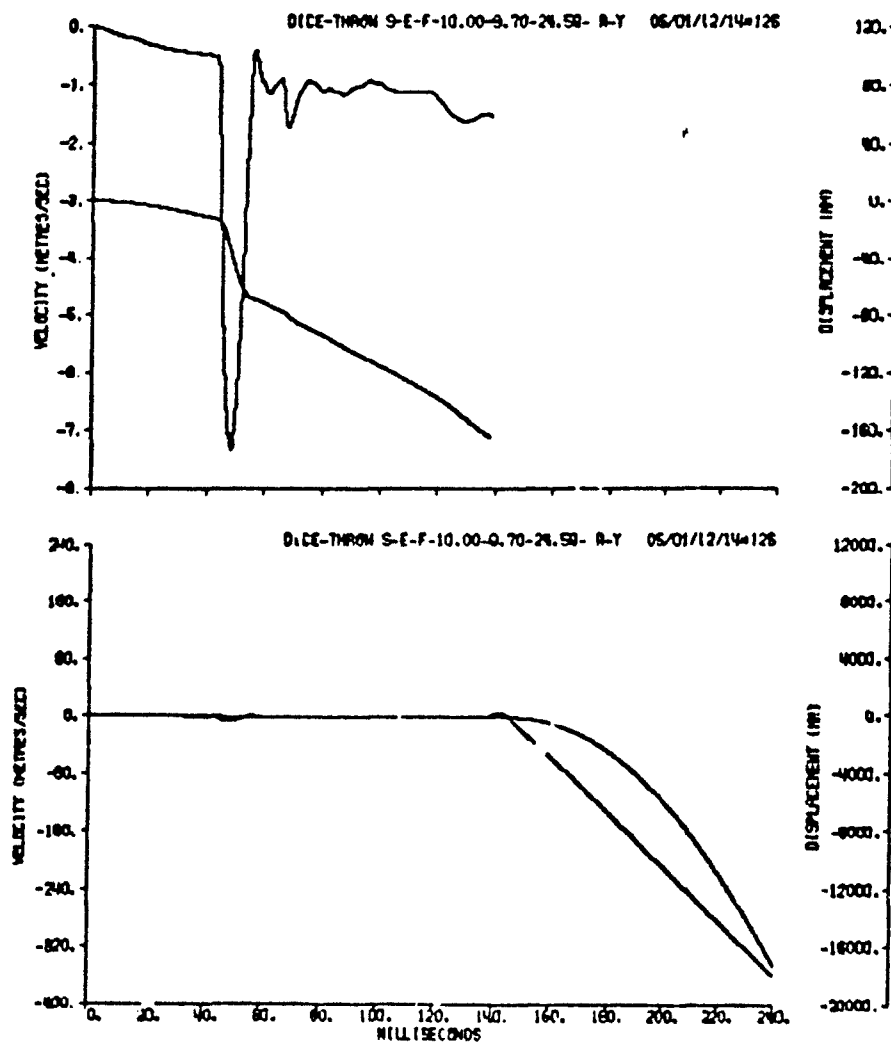
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AFML-TR-77-001

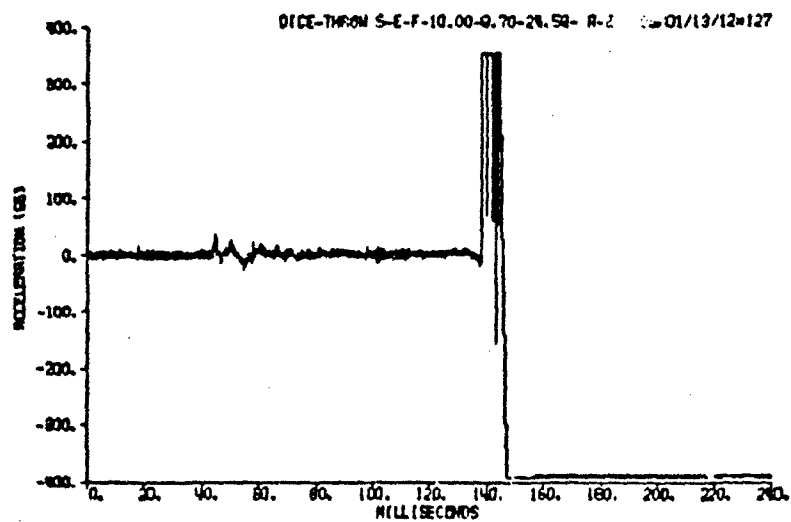
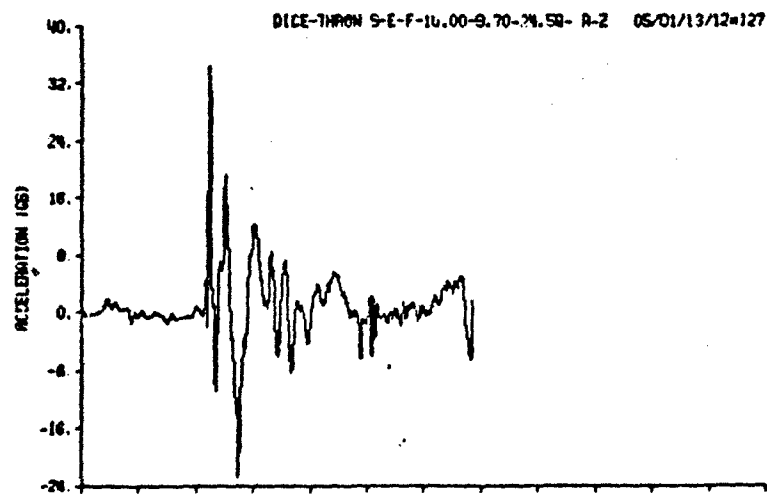


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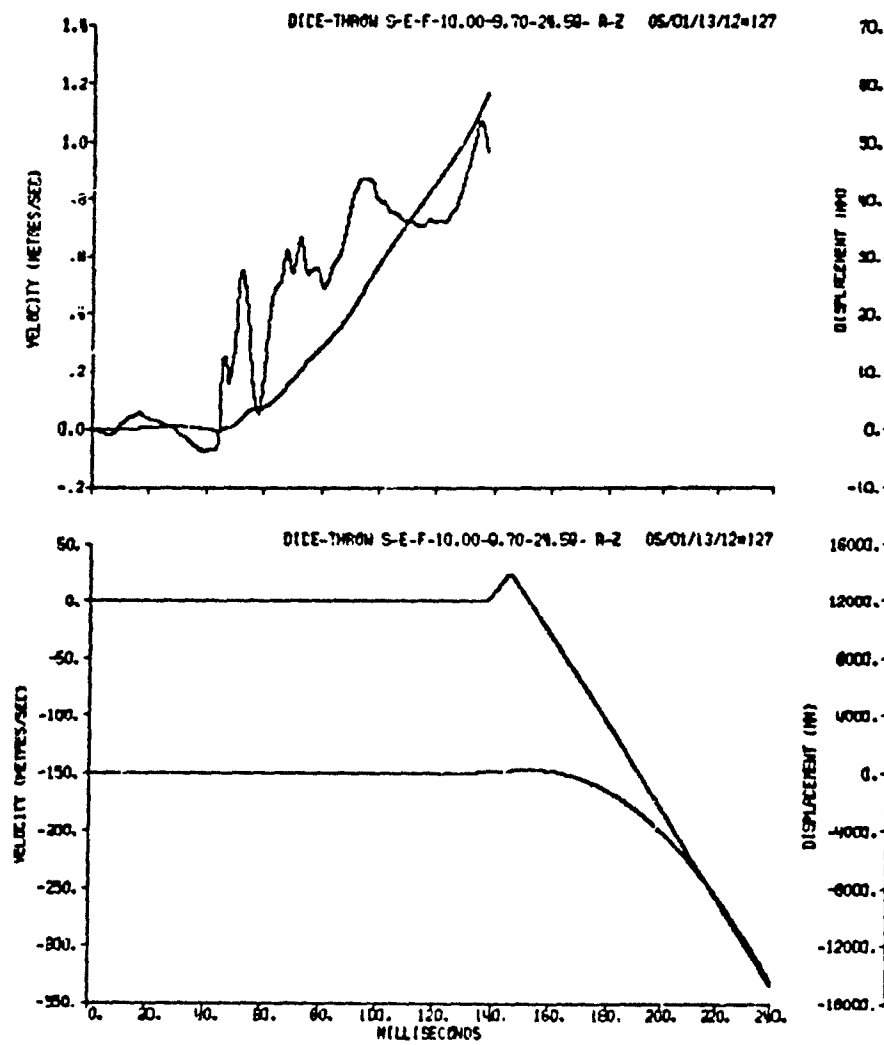




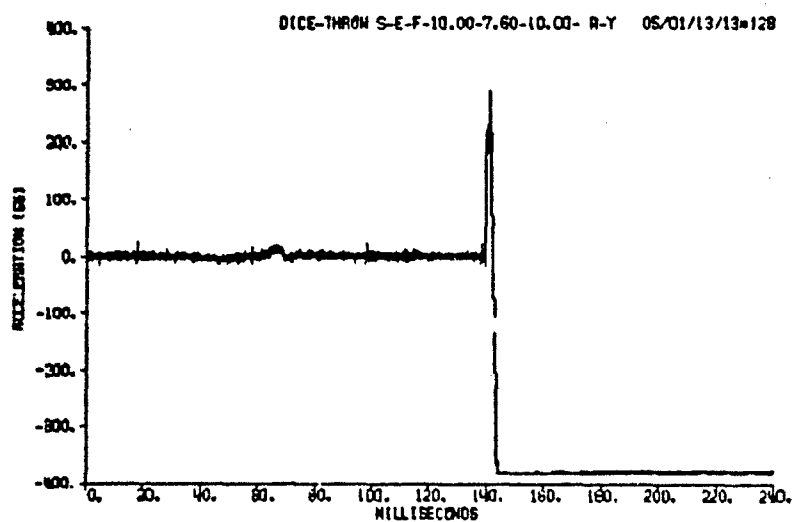
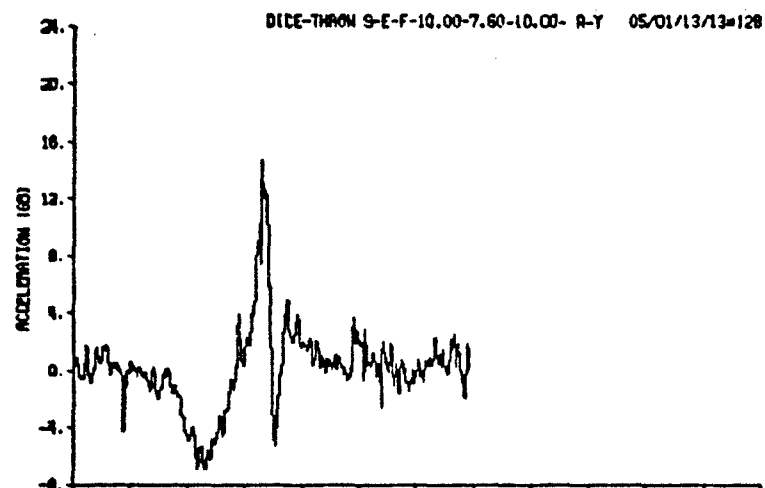
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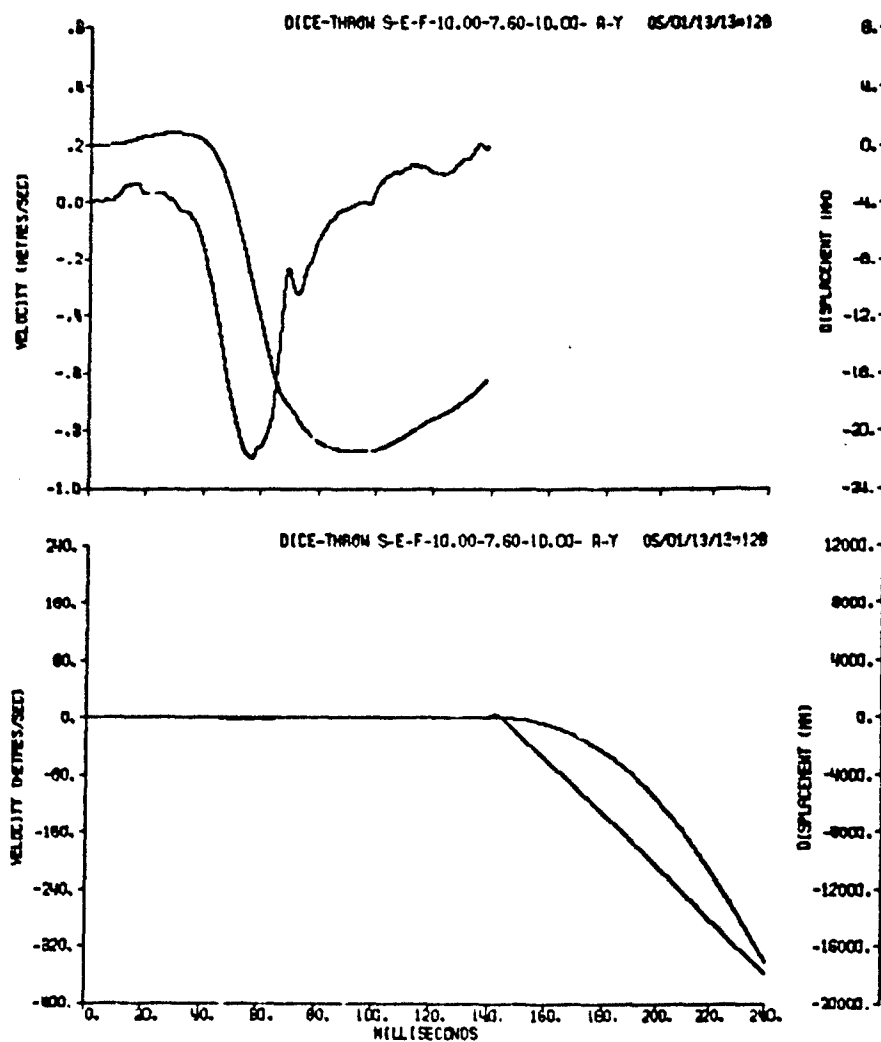
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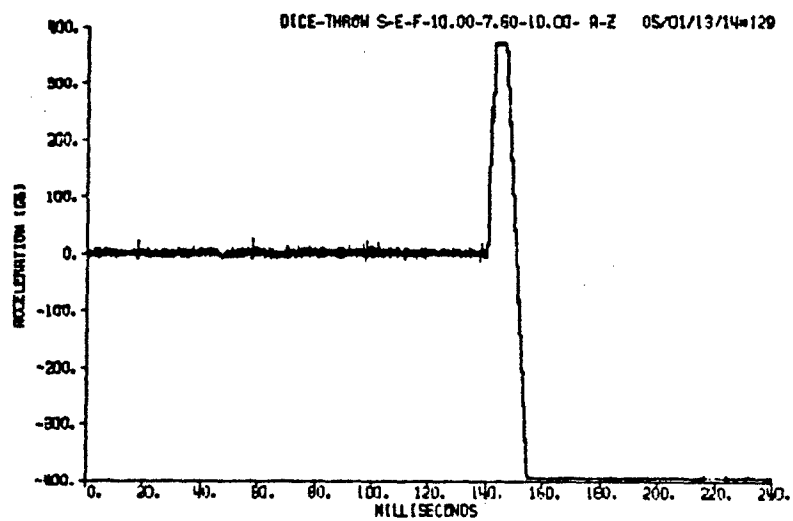
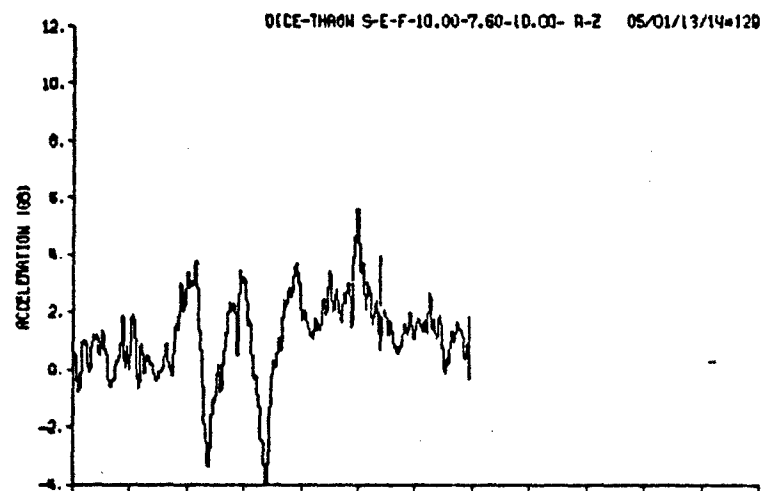
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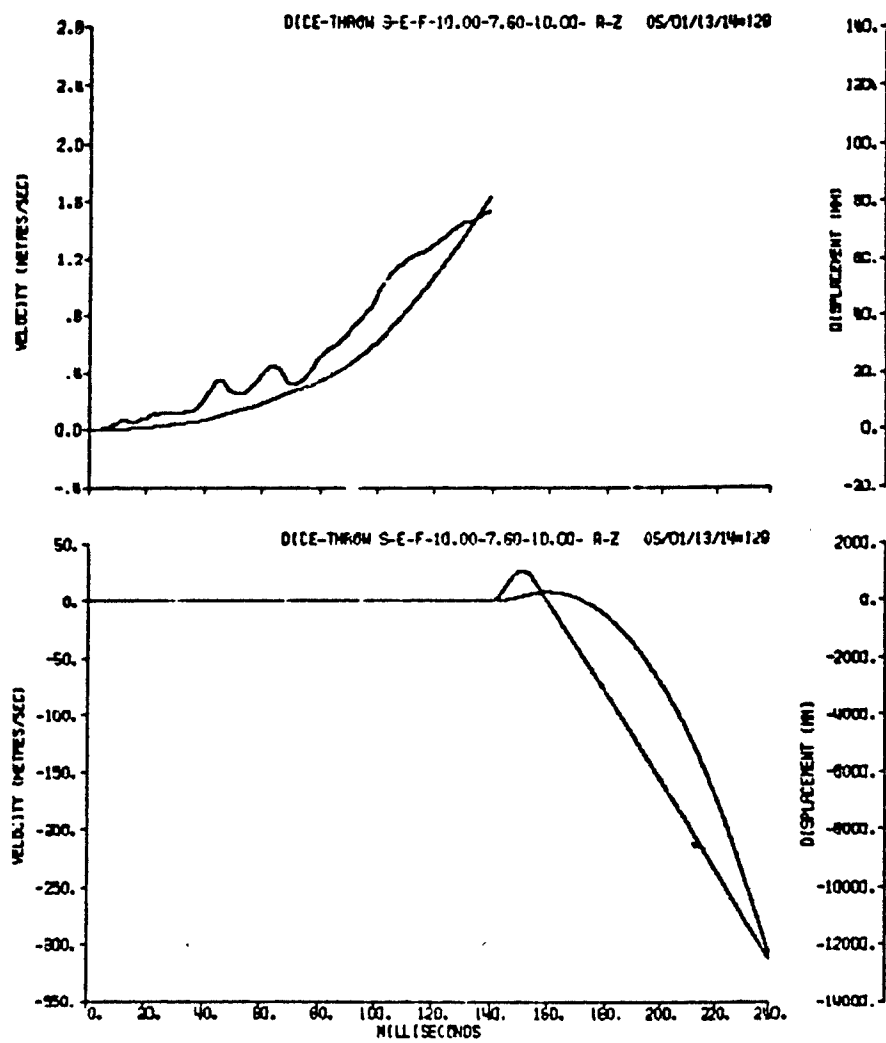
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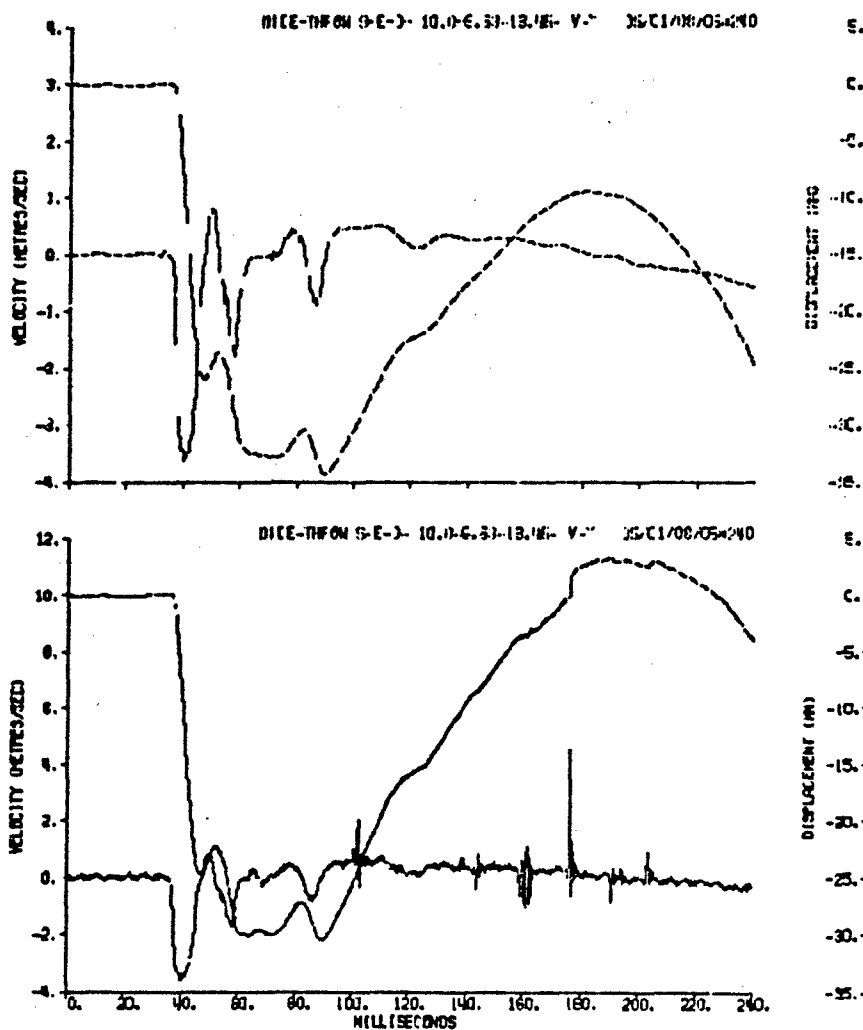
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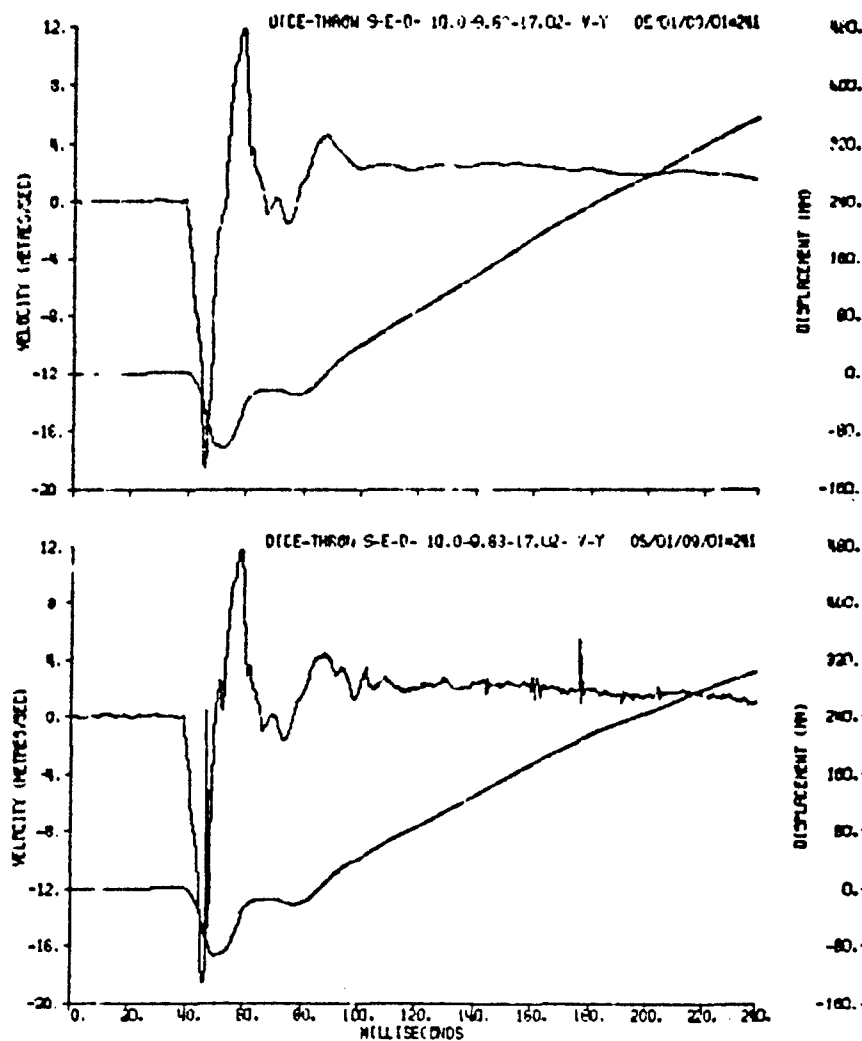
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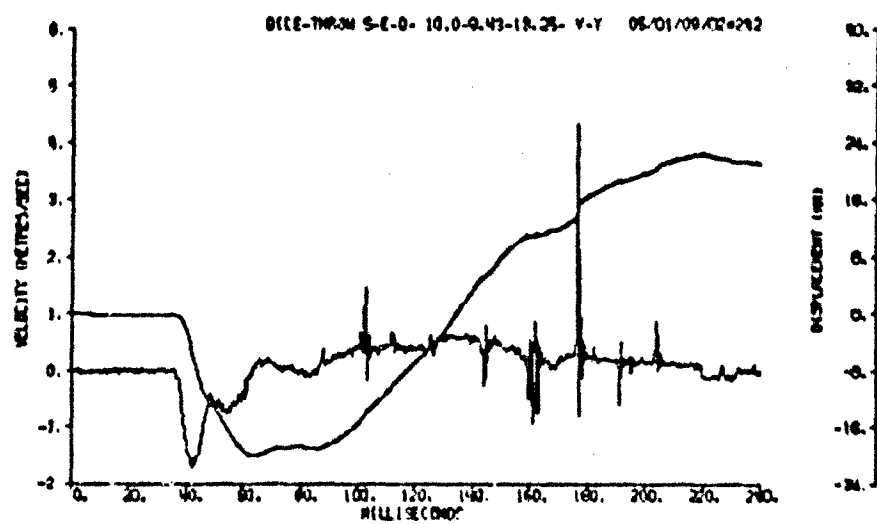
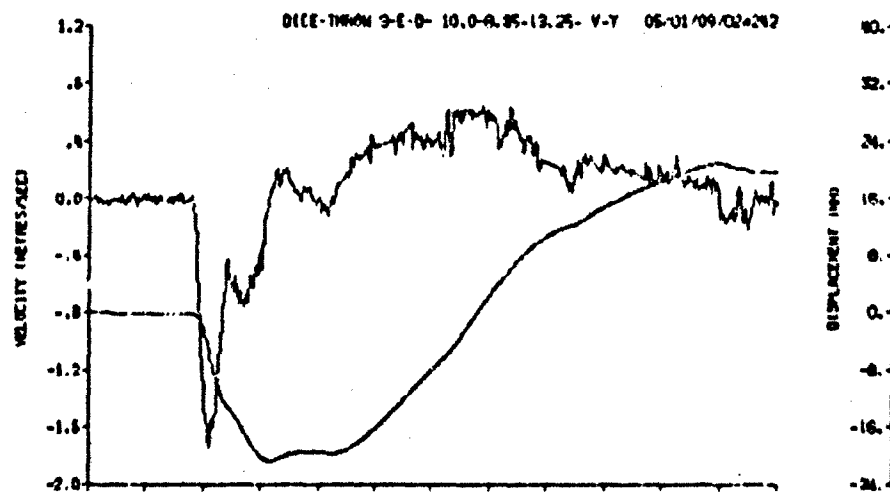


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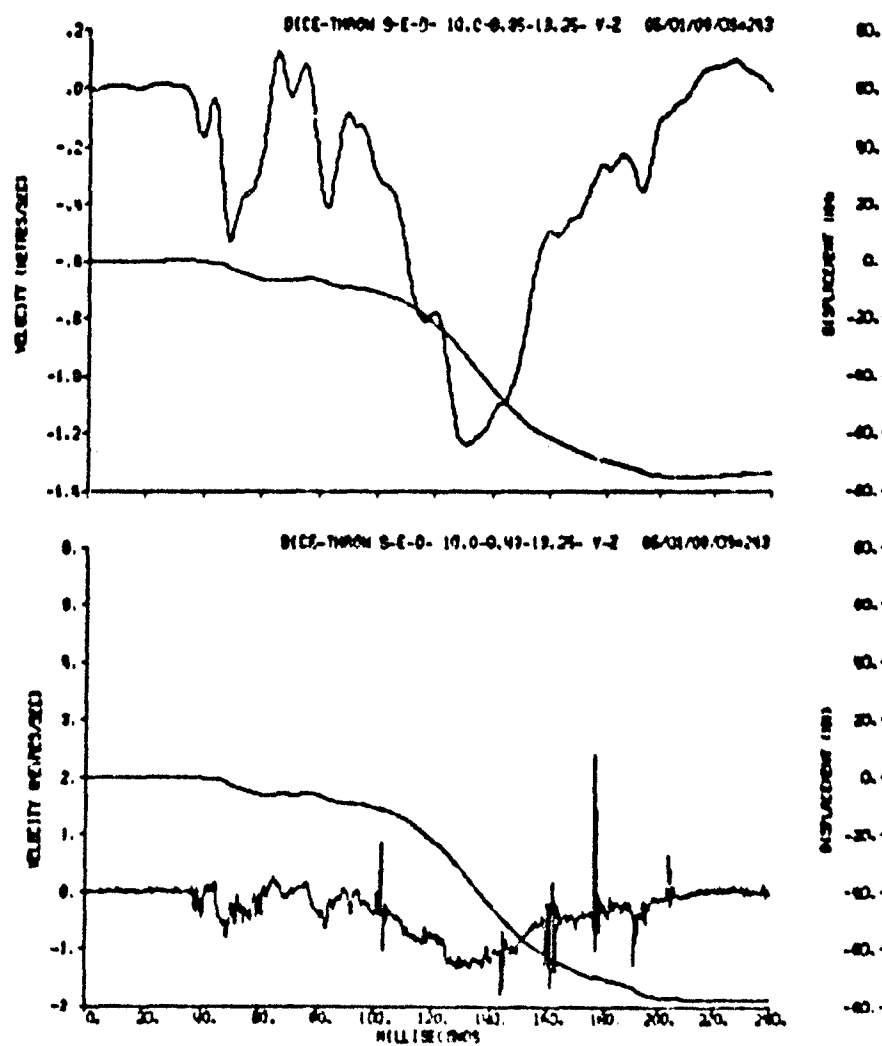




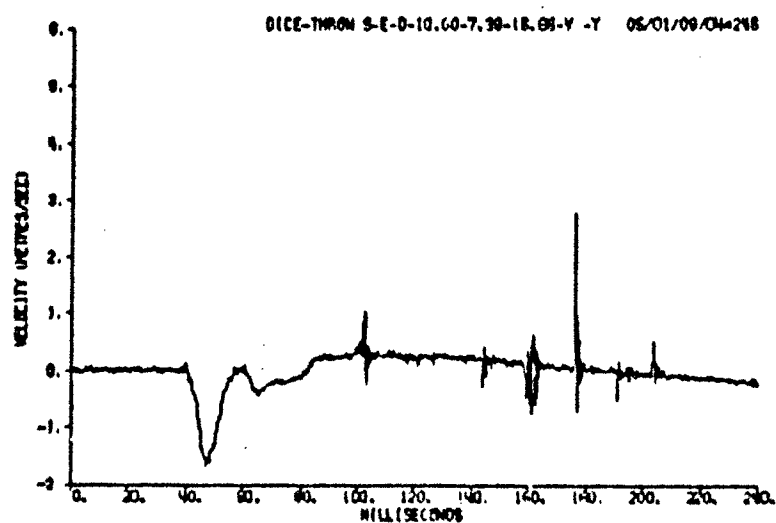
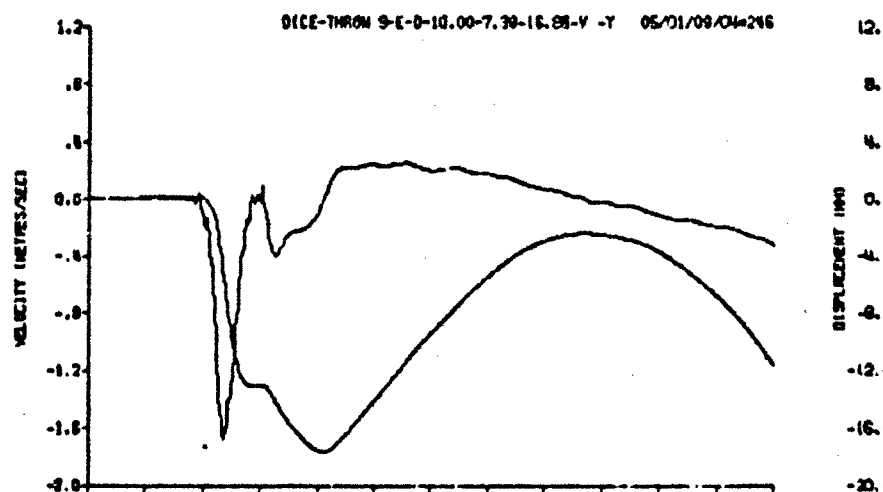
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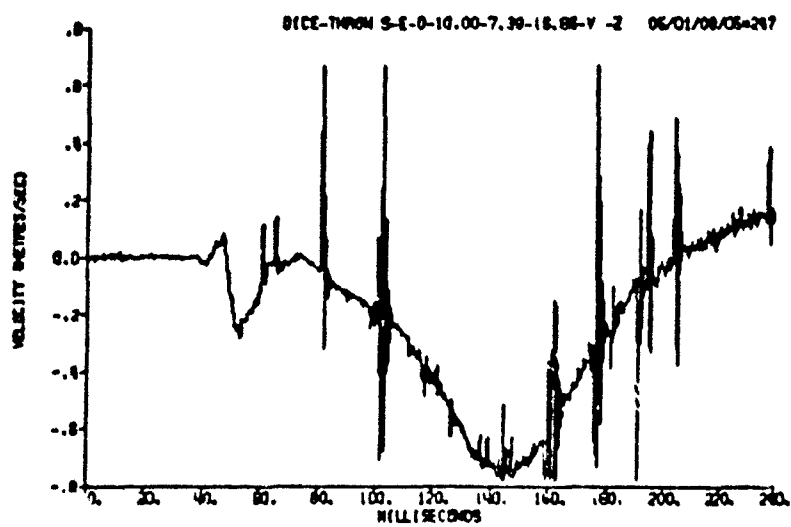
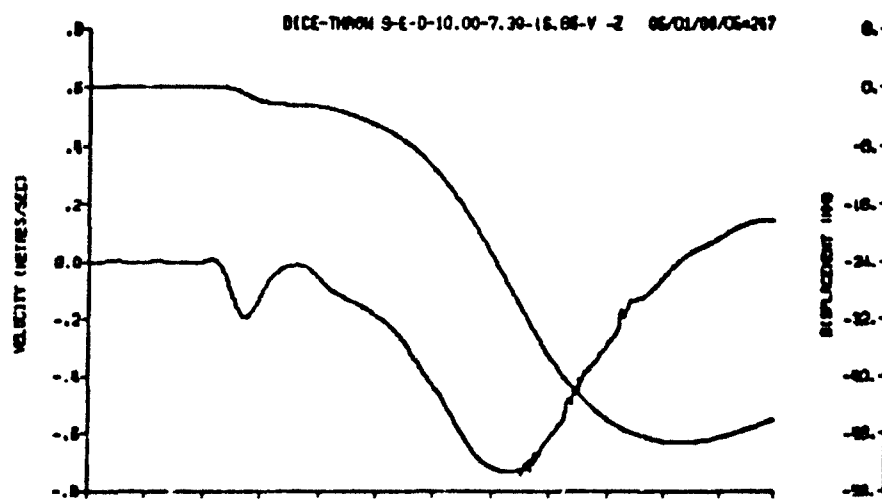
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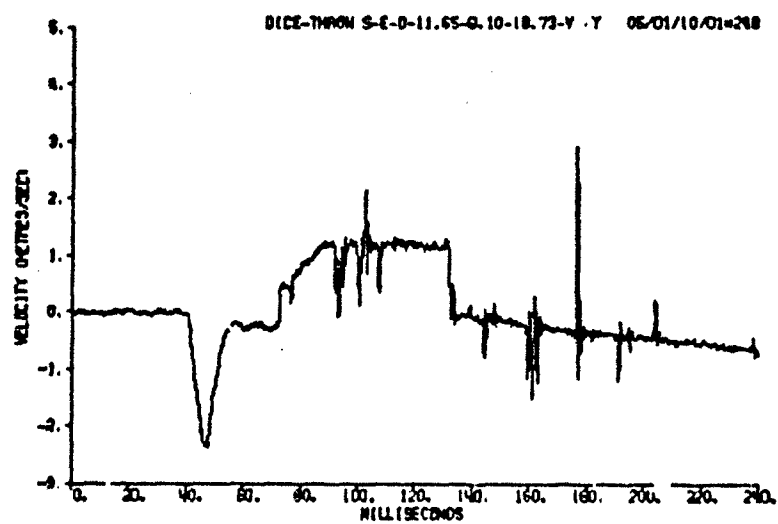
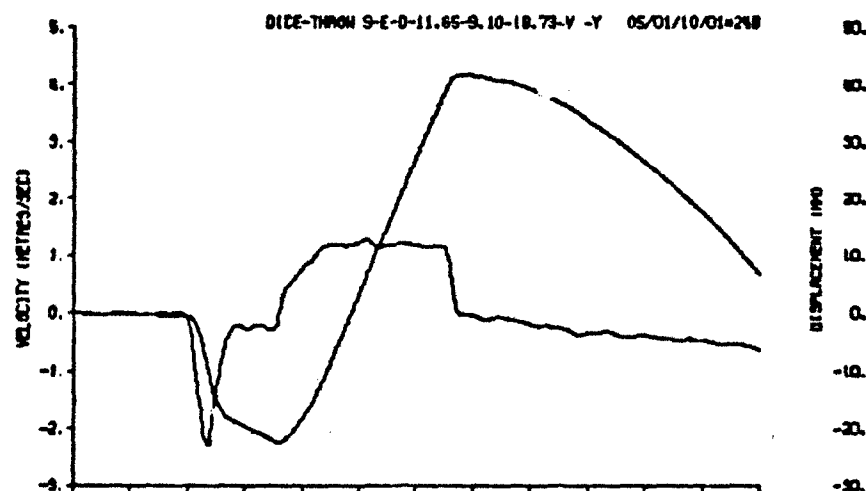


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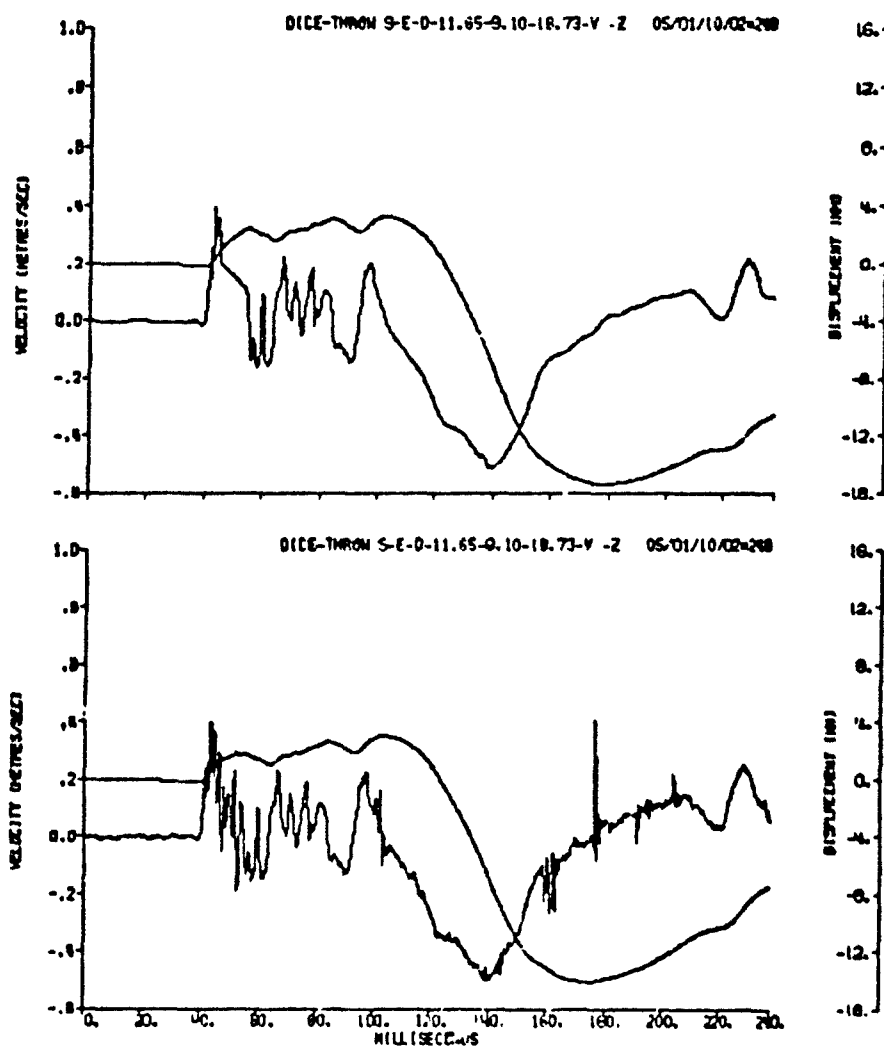


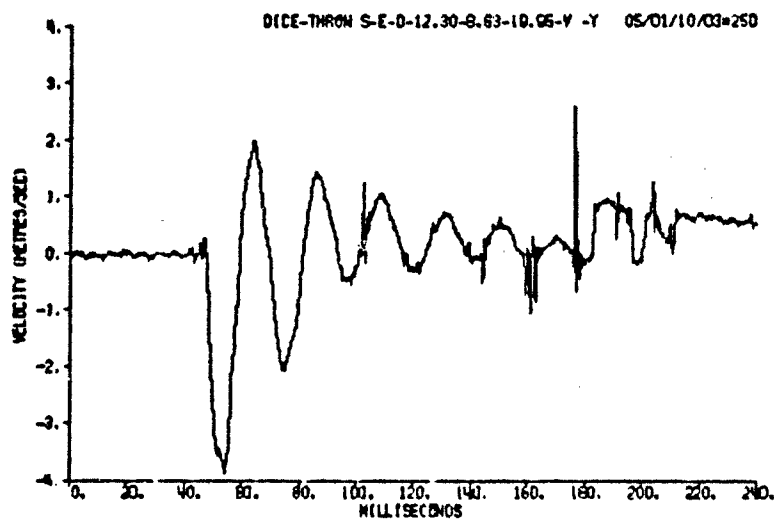
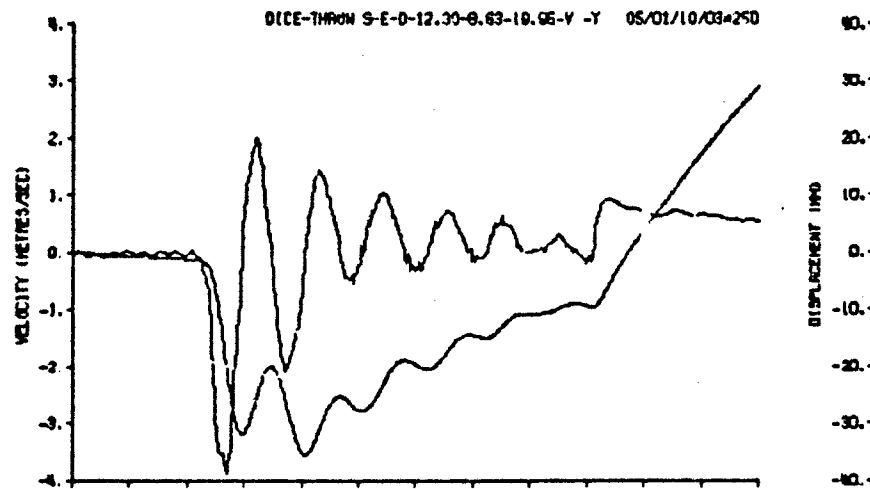
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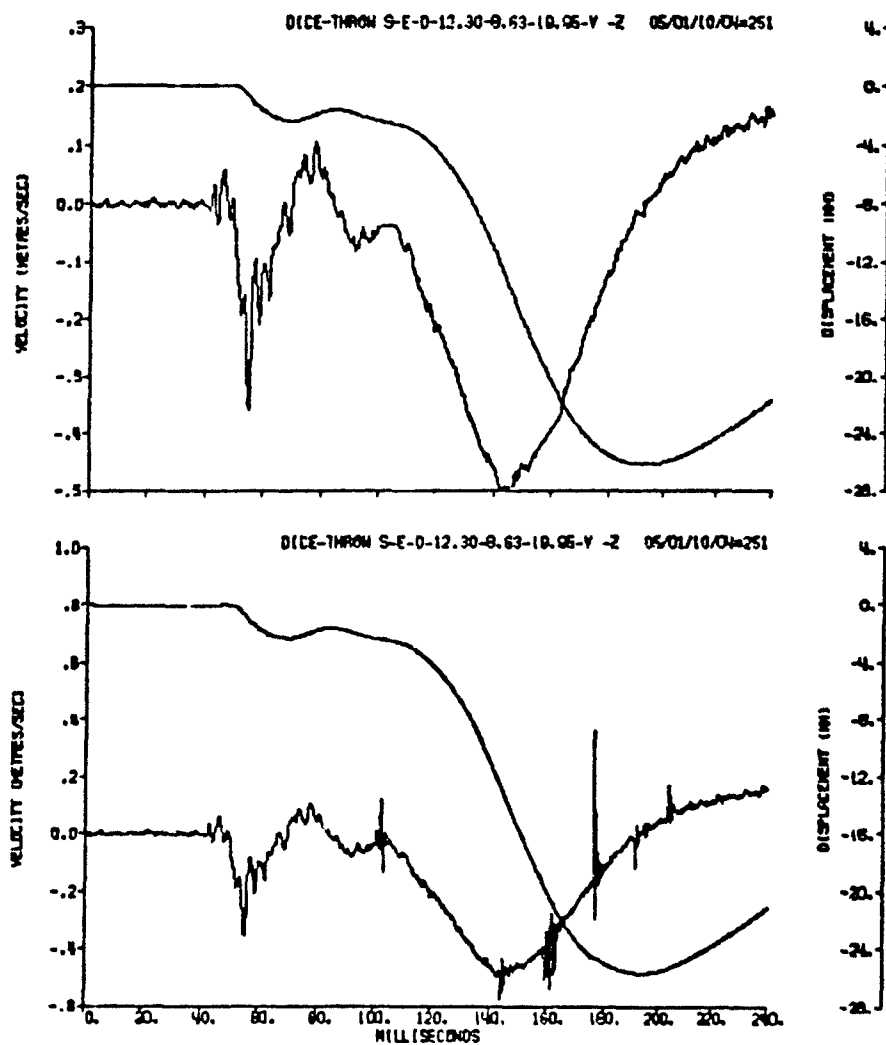




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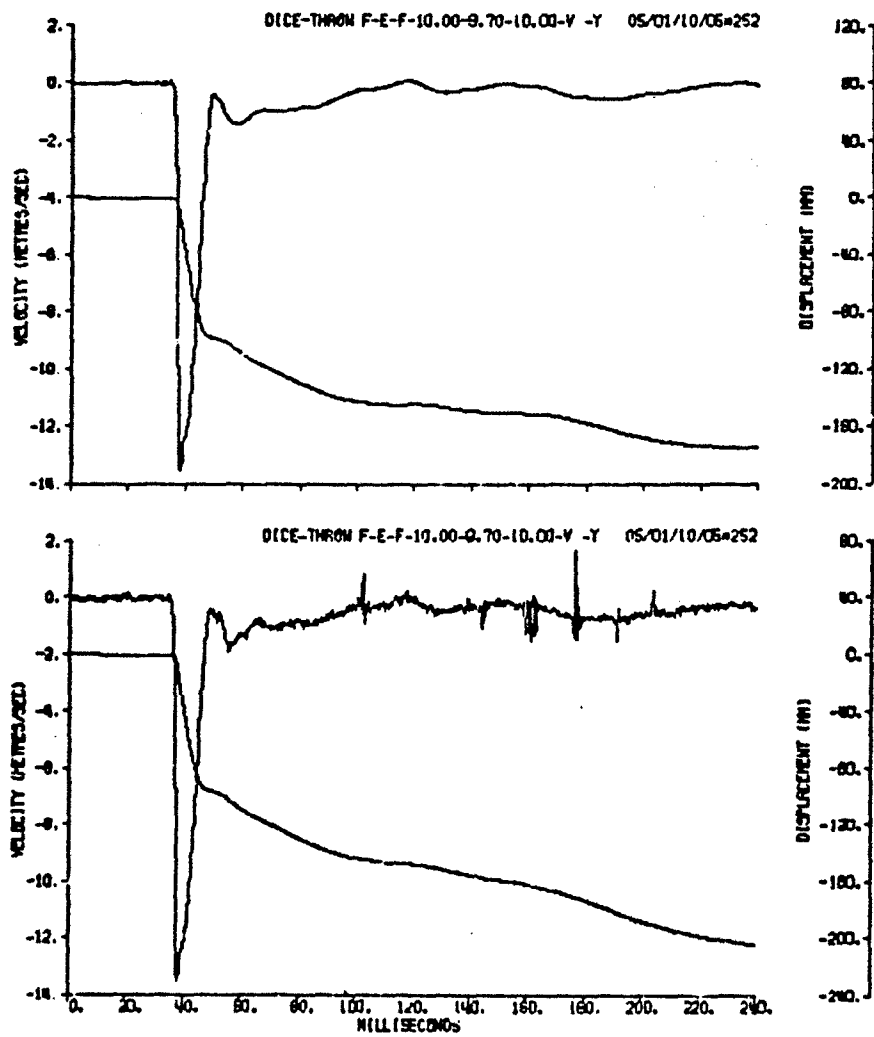




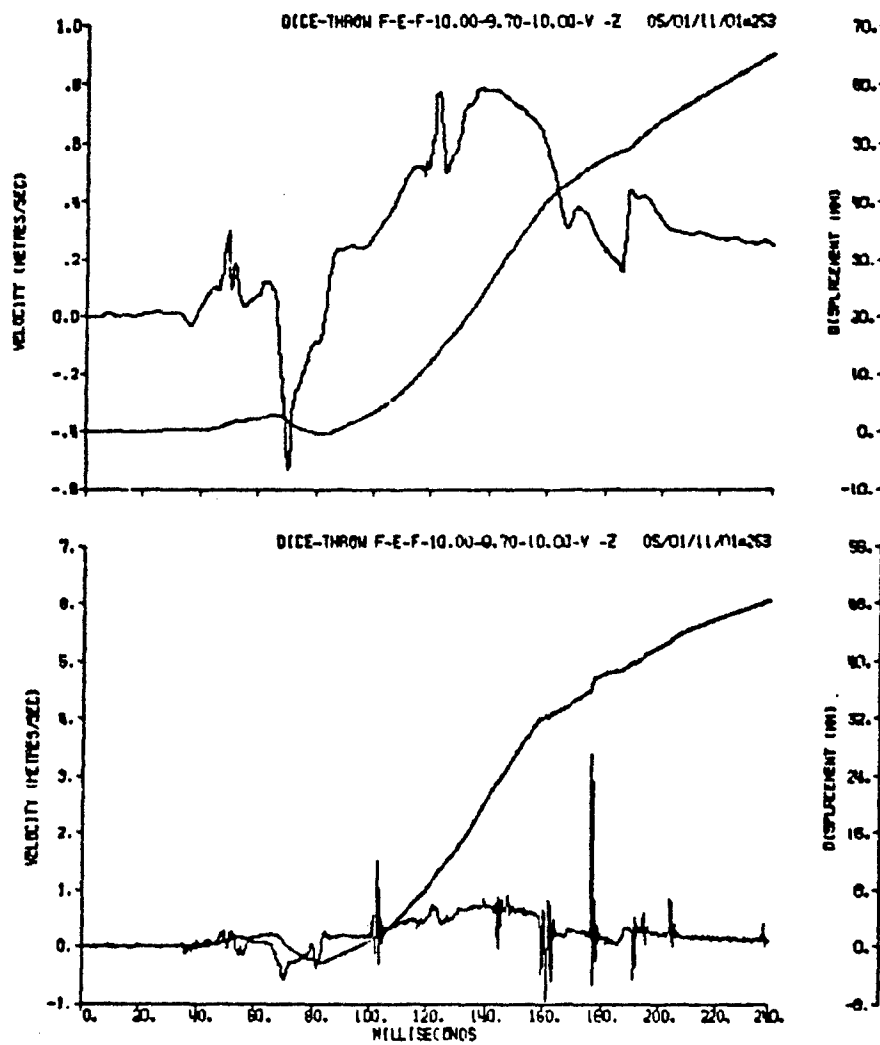




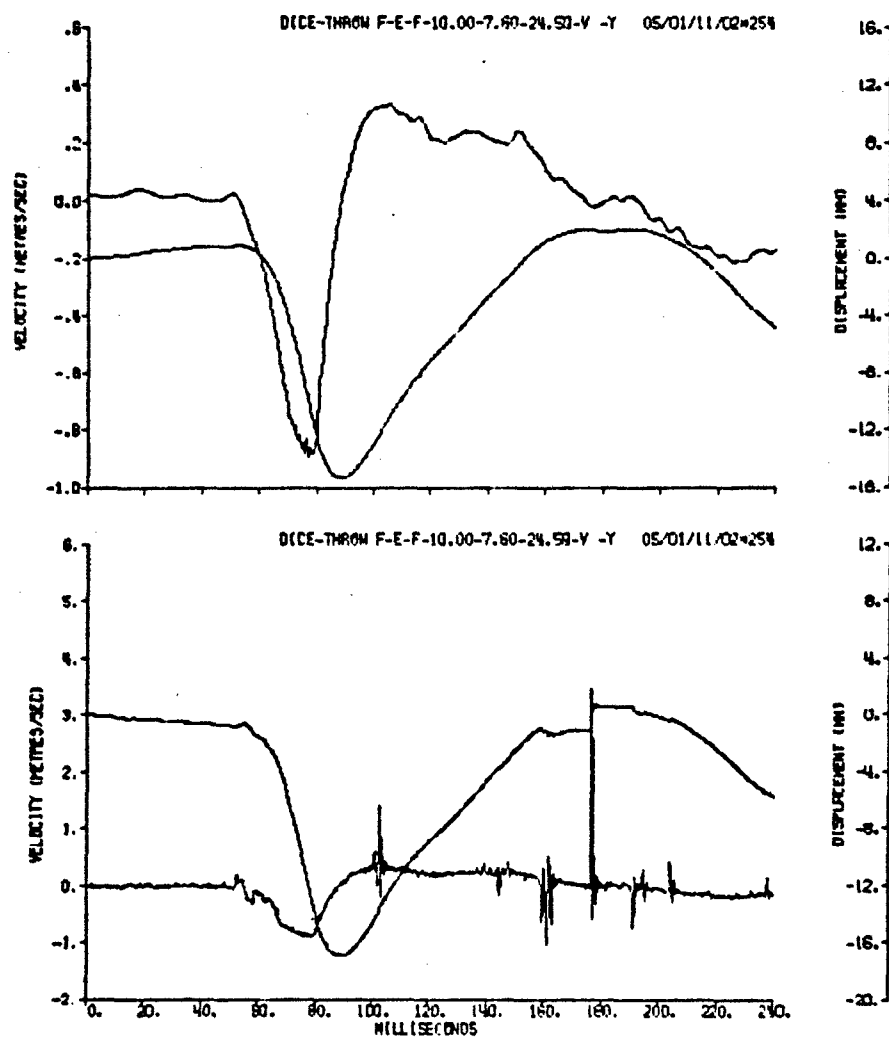
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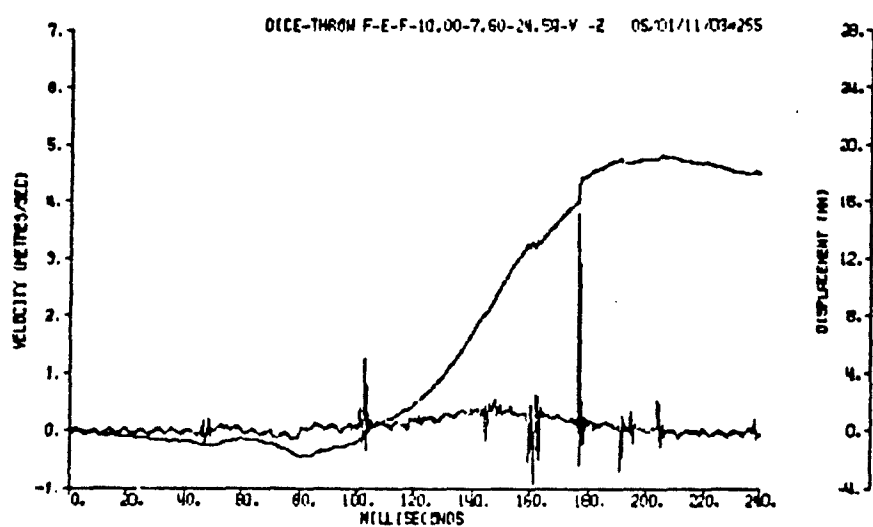
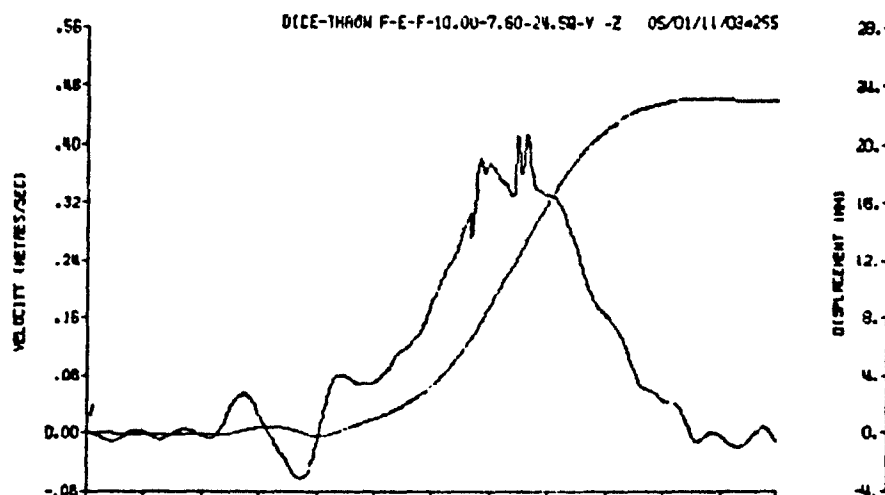
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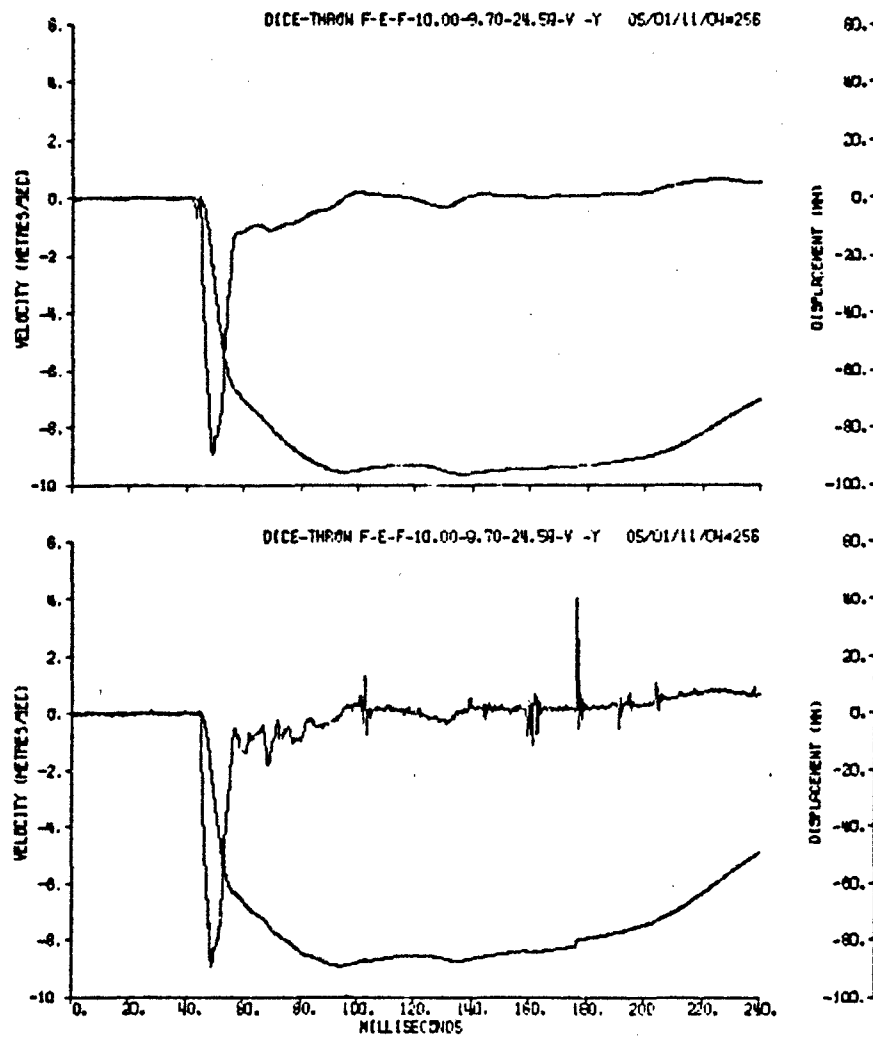


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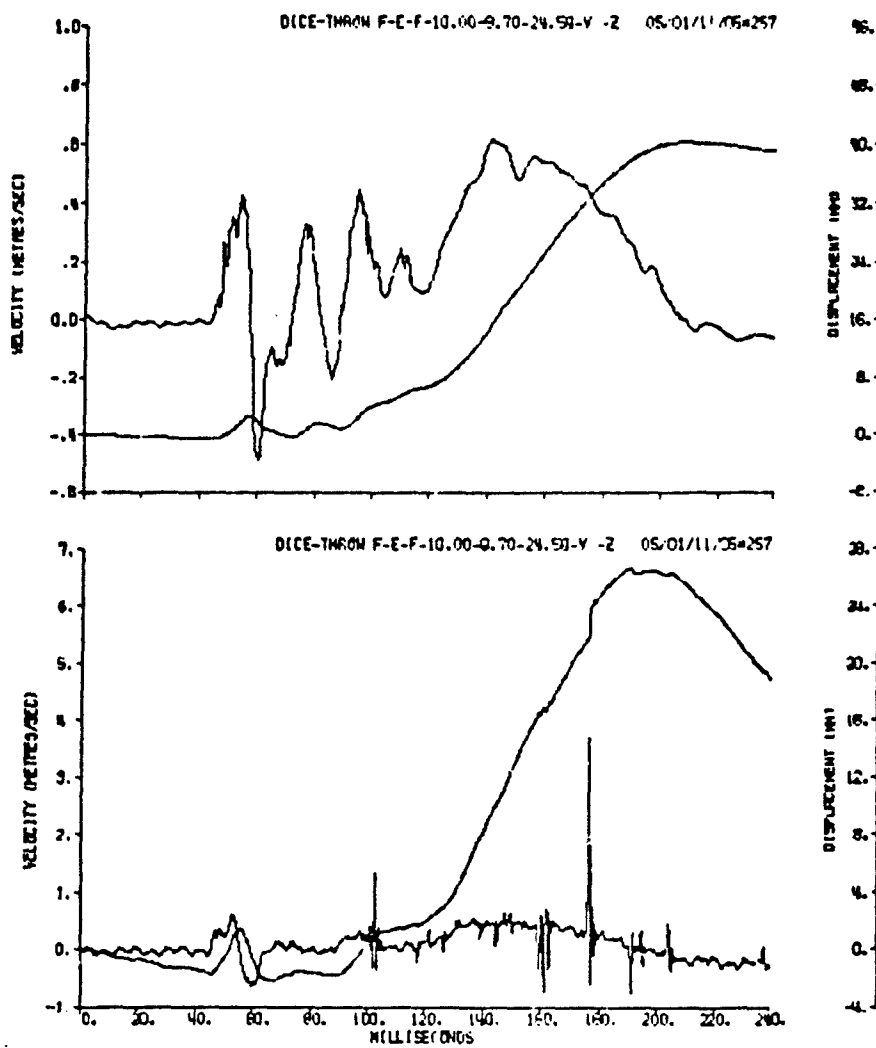


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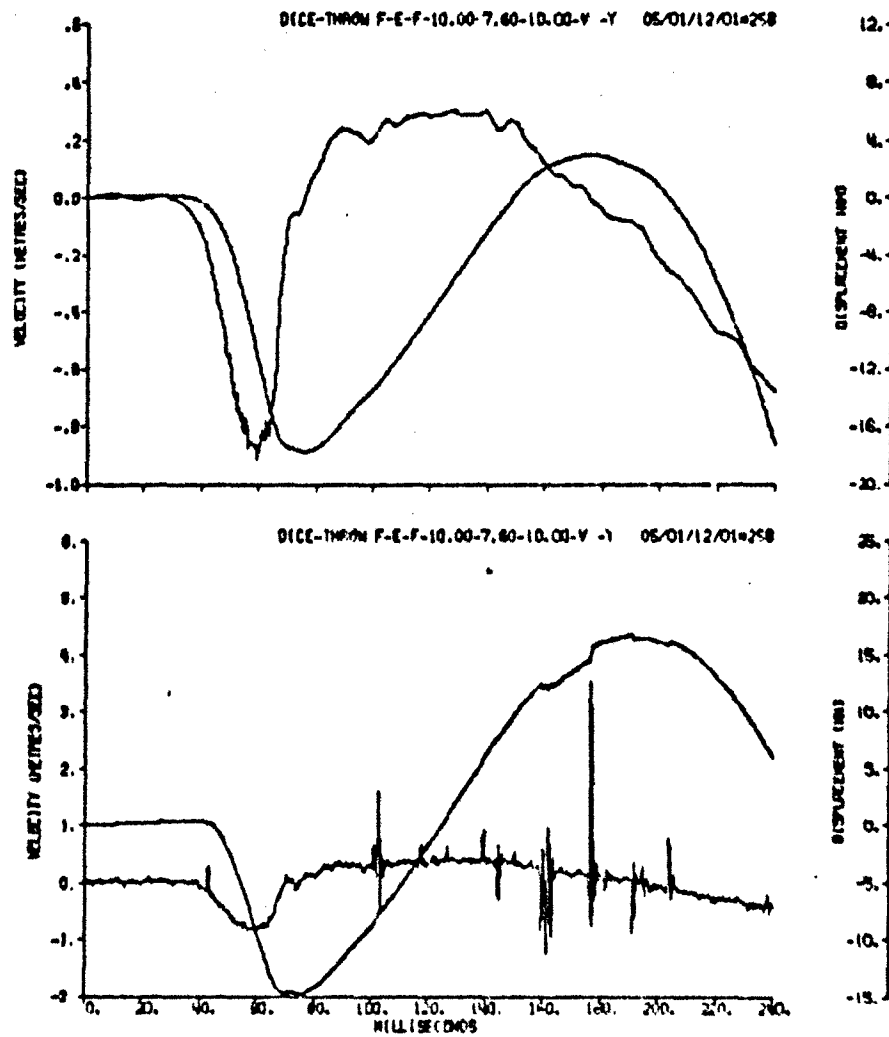




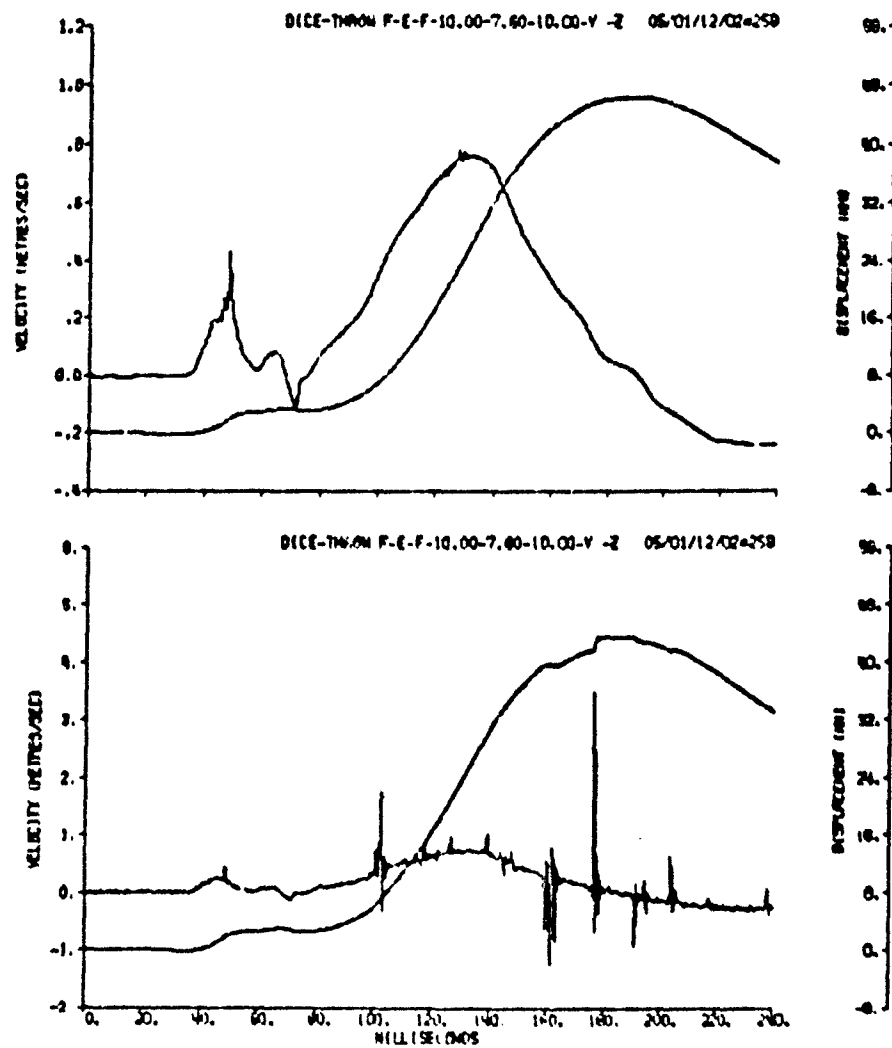
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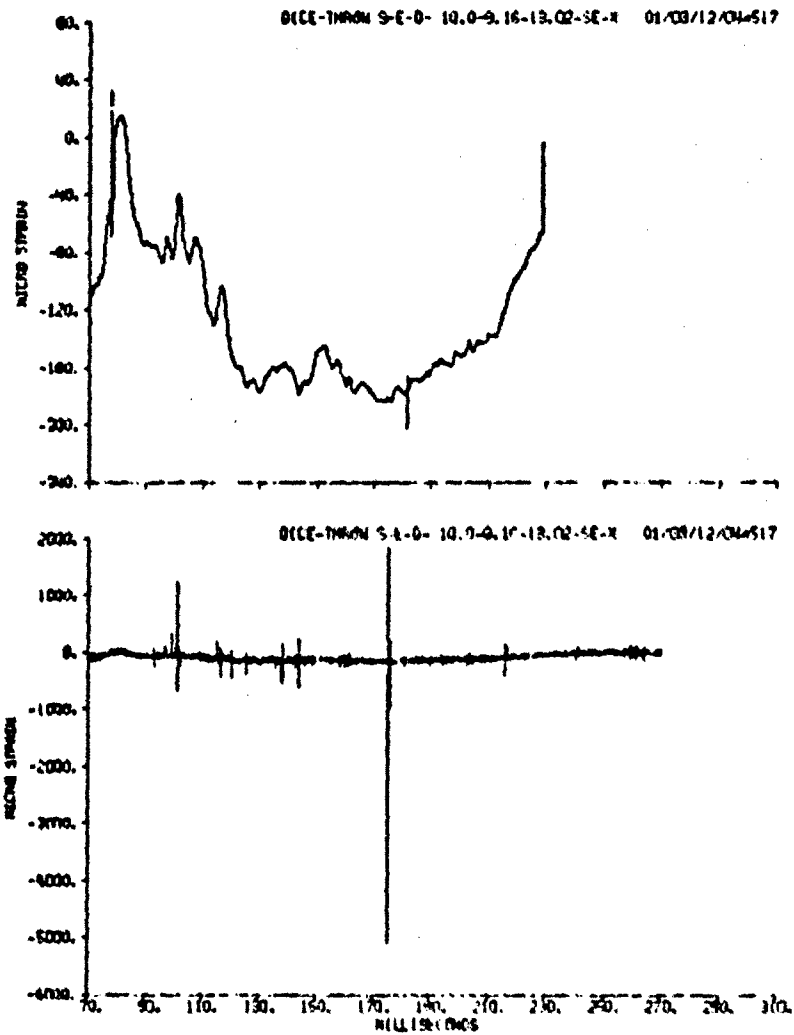


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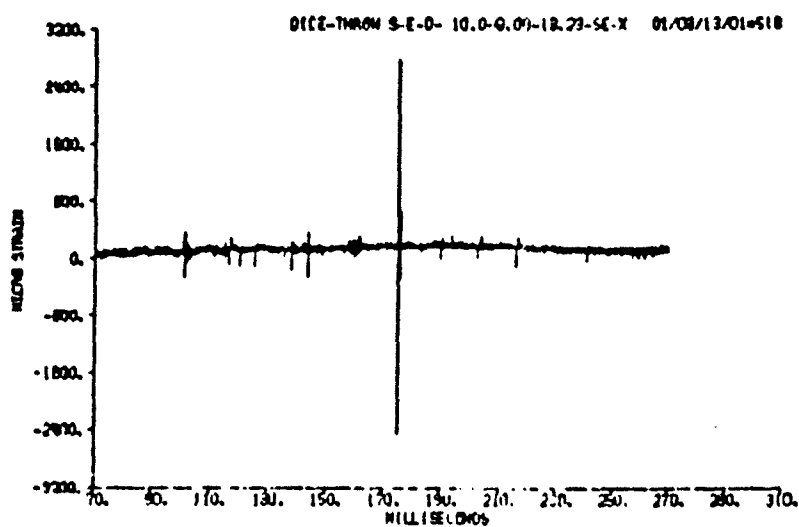
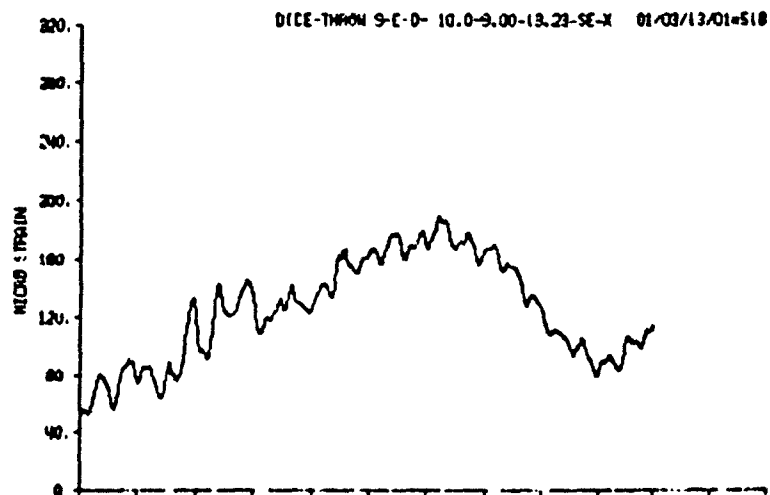




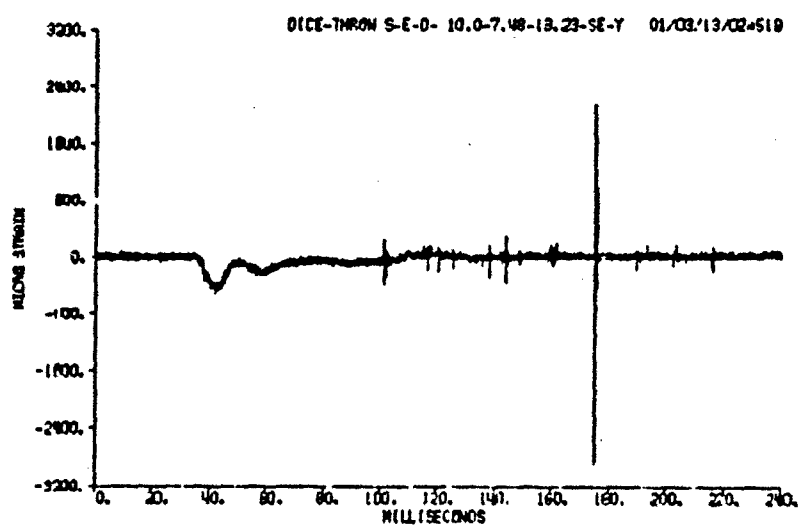
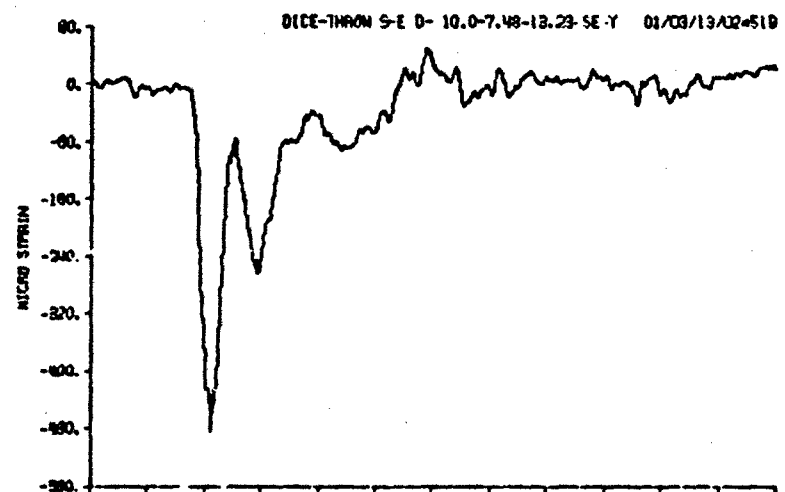
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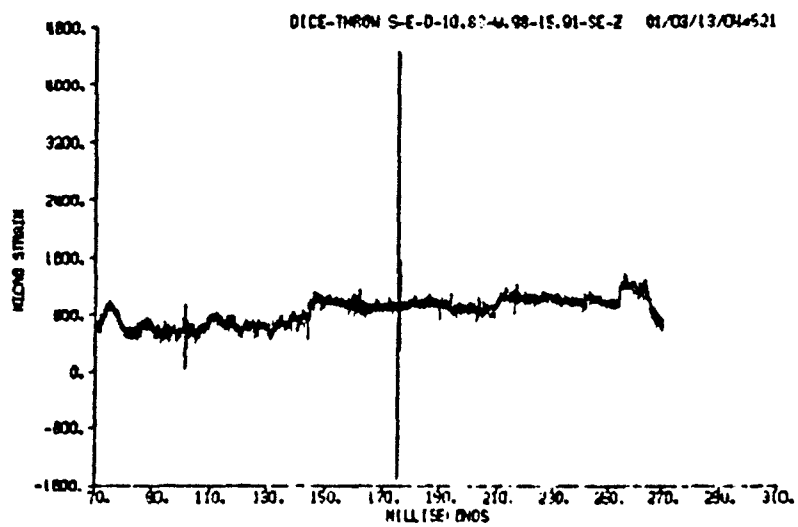
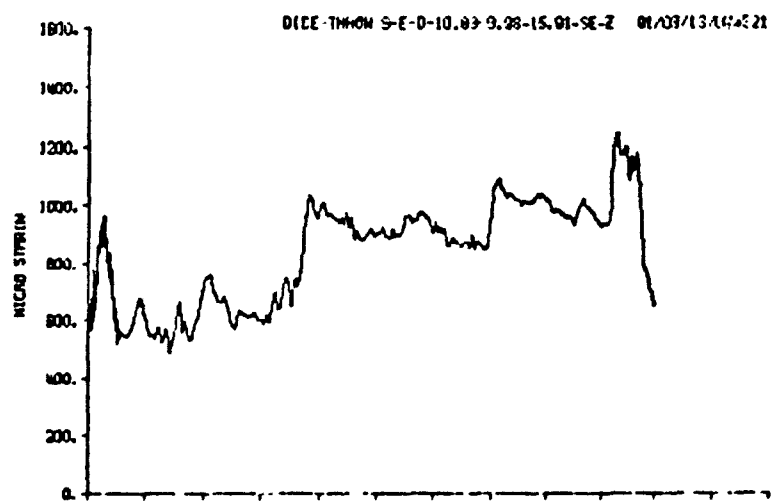
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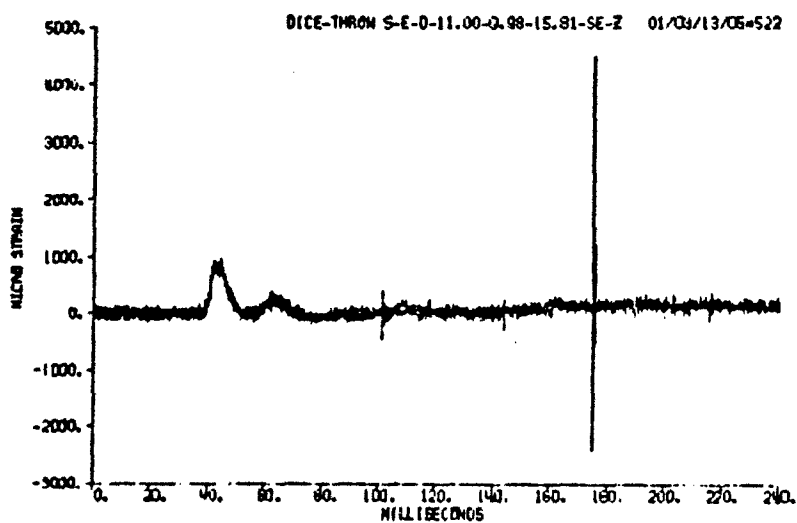
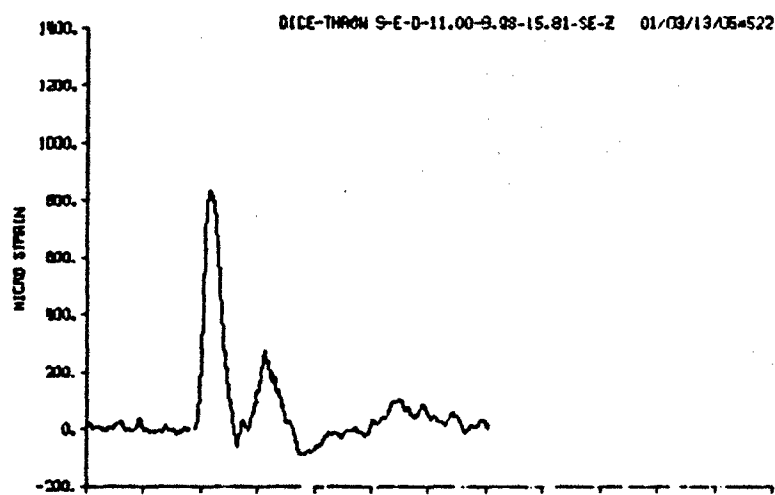
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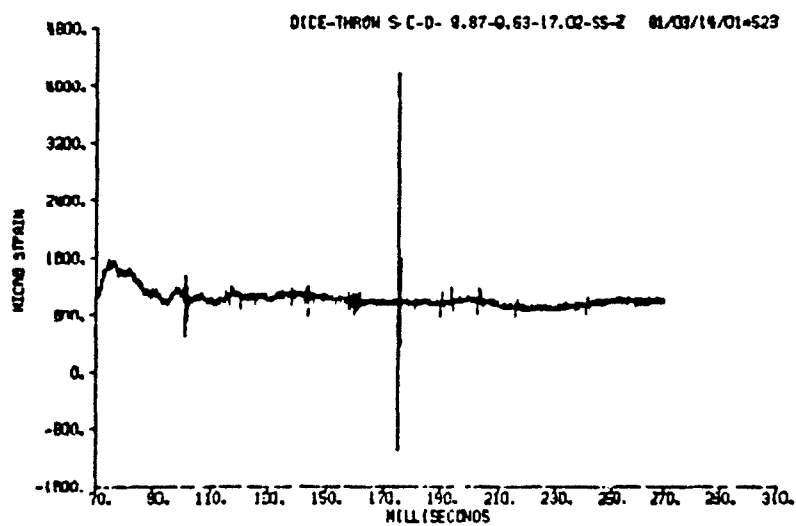
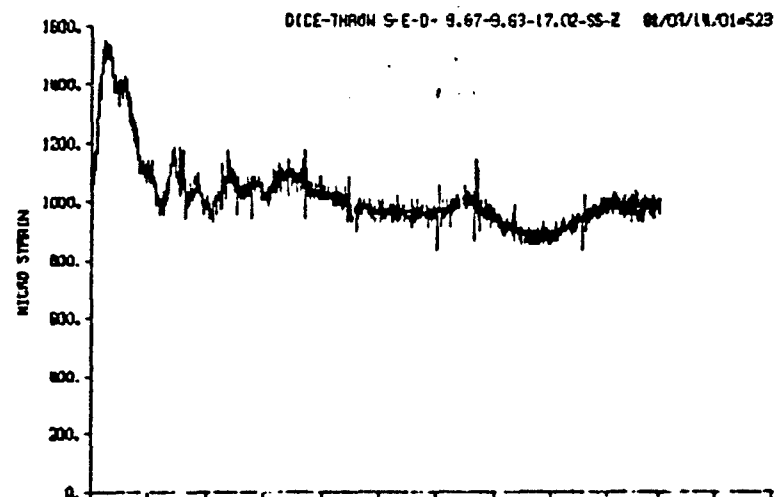
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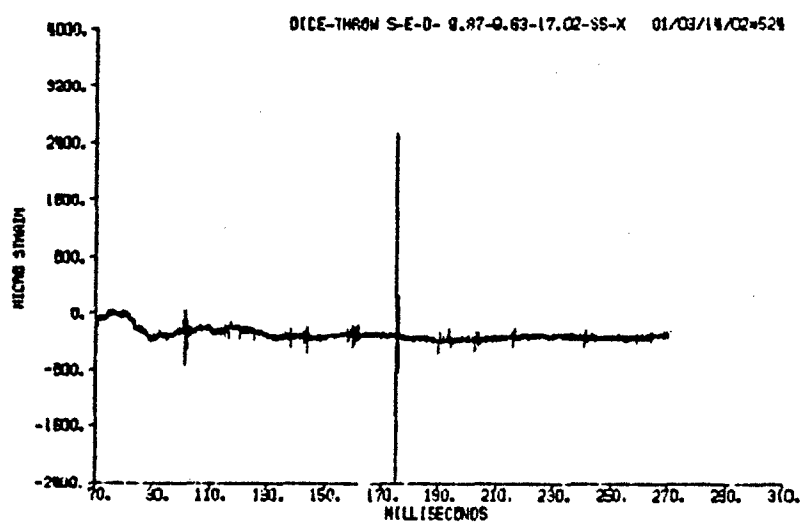
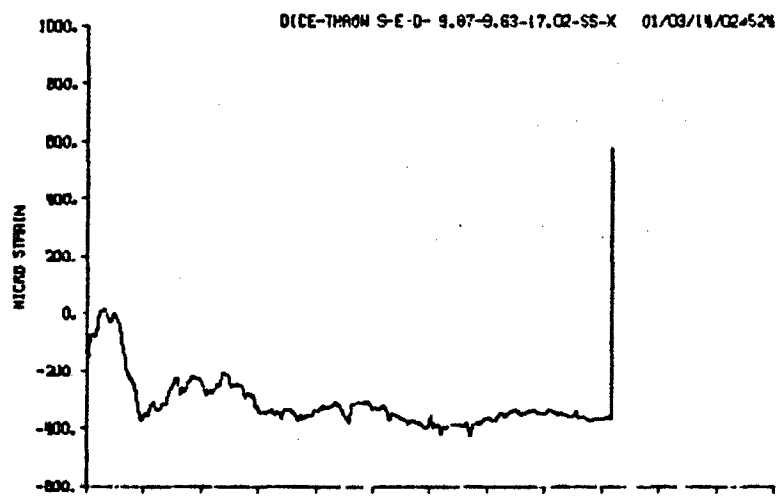
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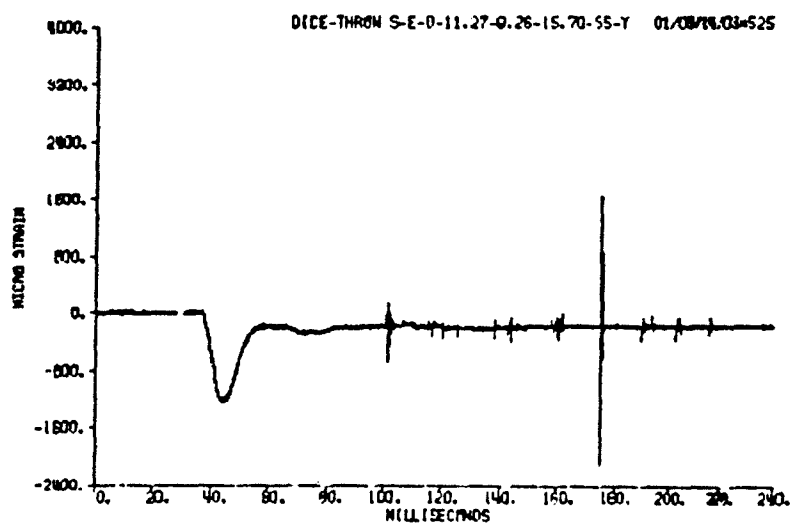
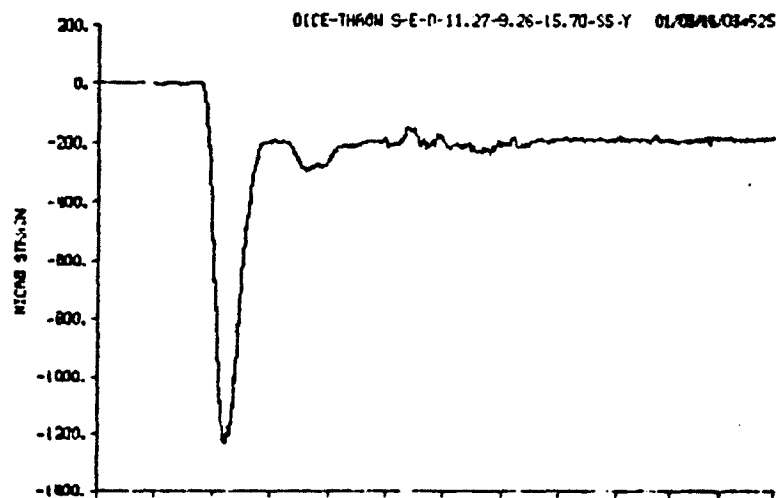


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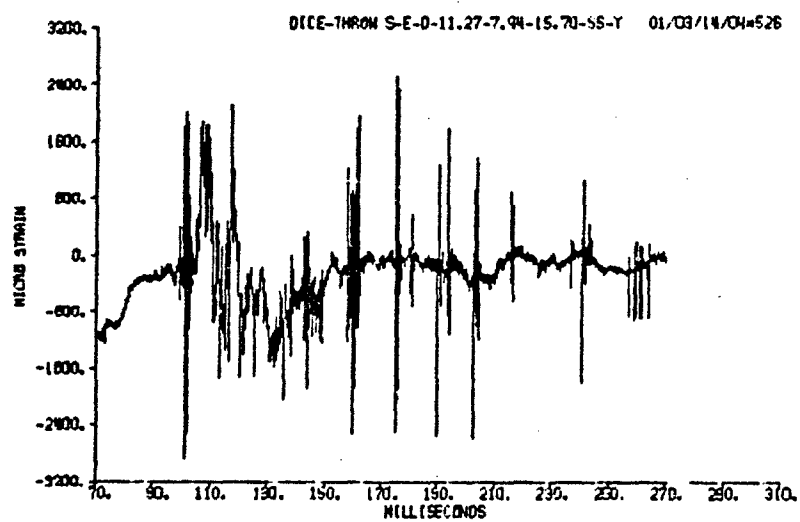
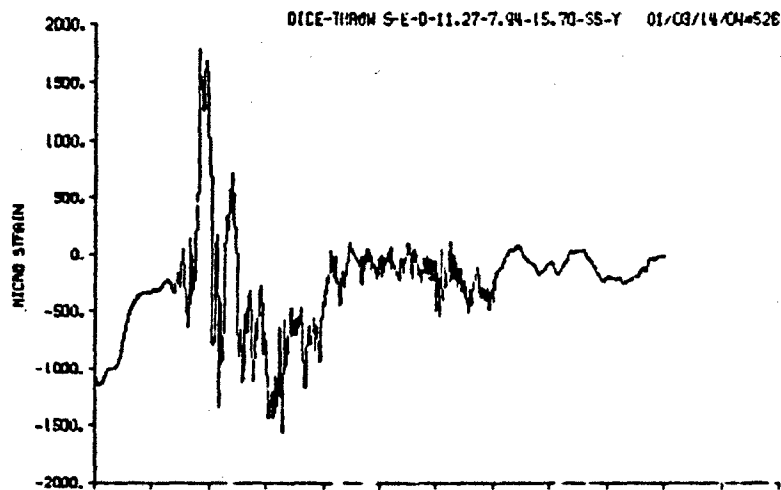
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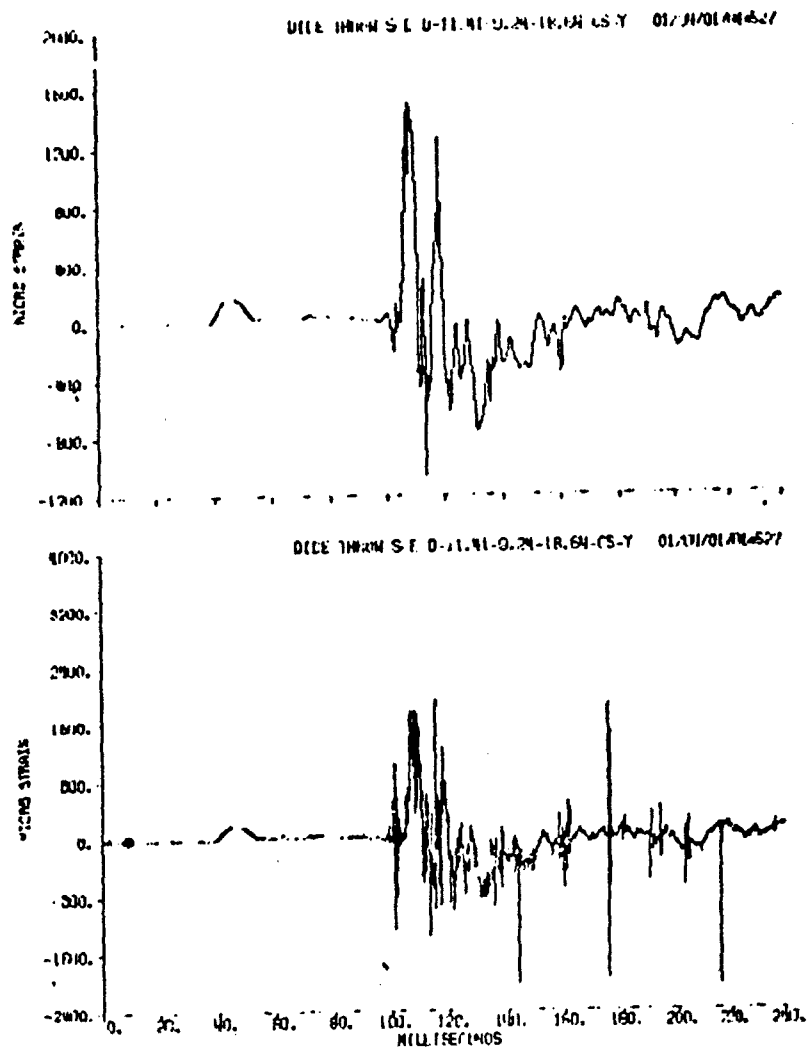


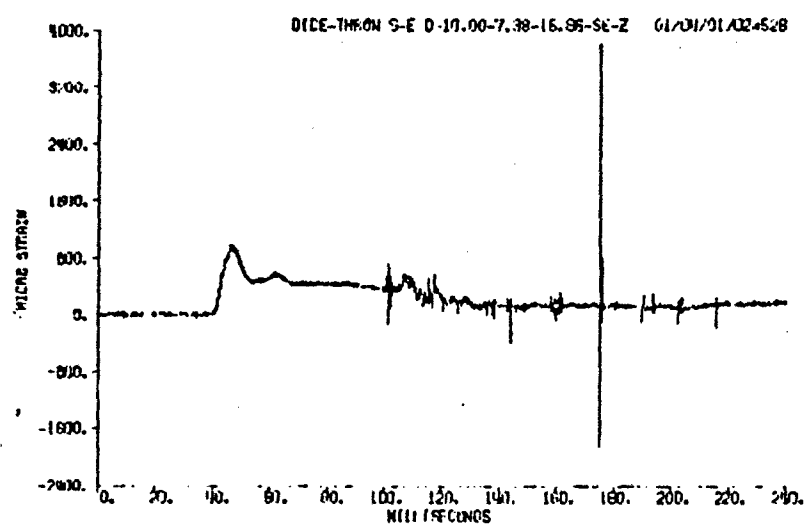
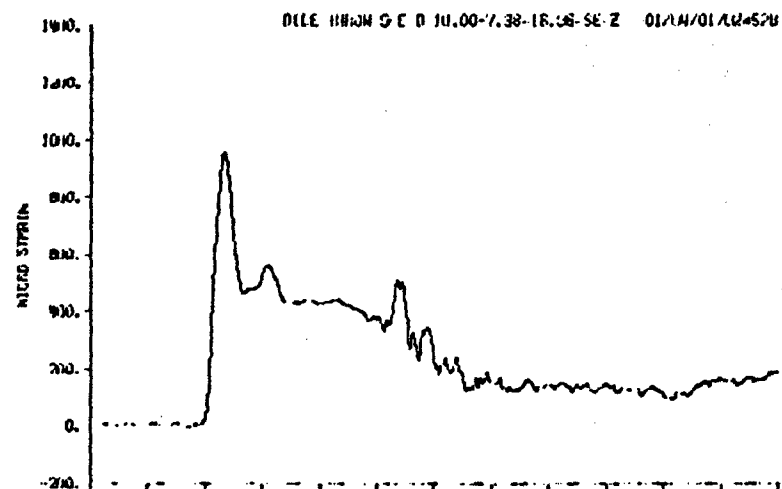


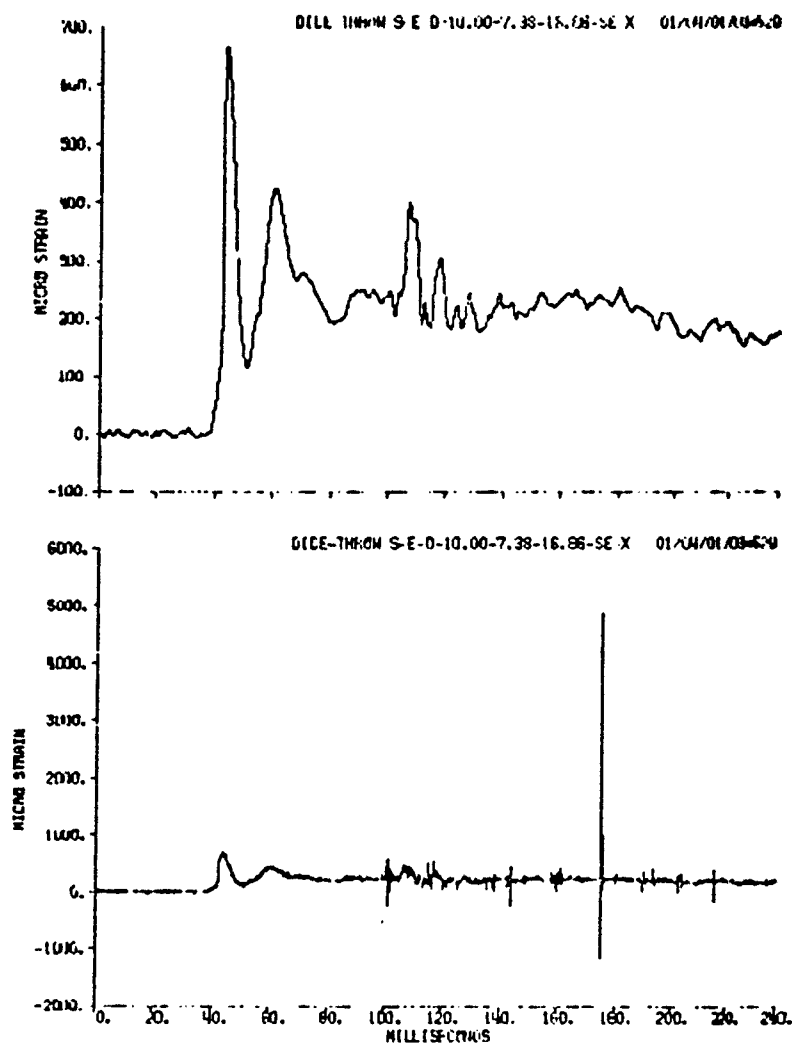
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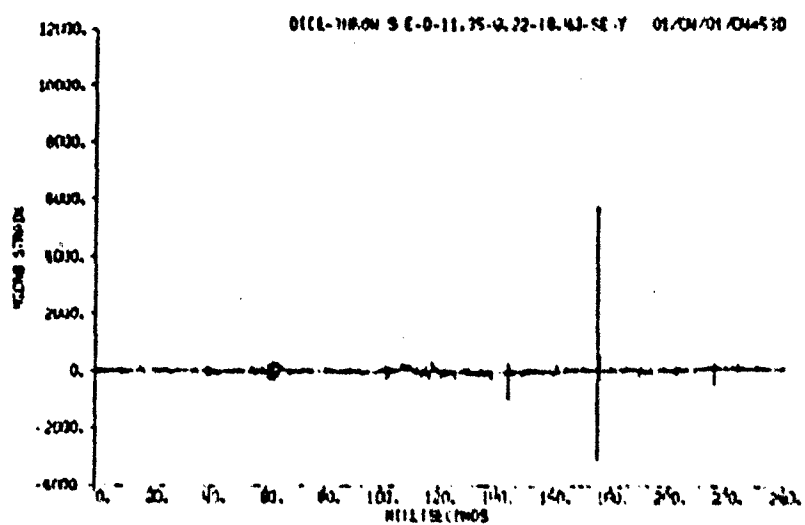
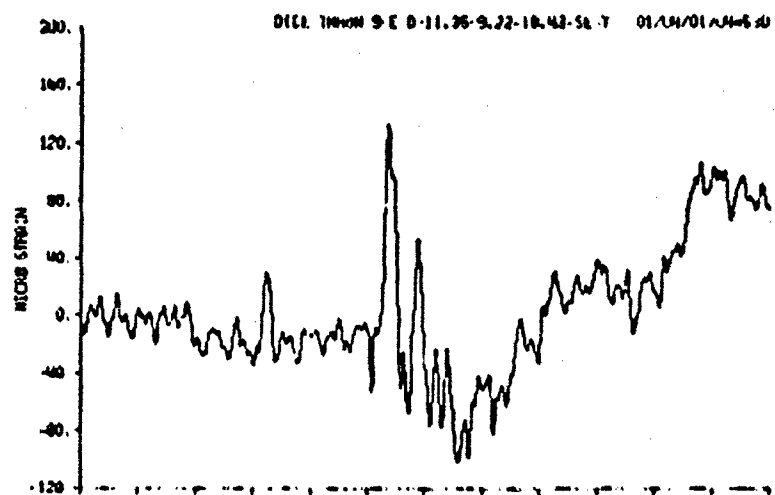
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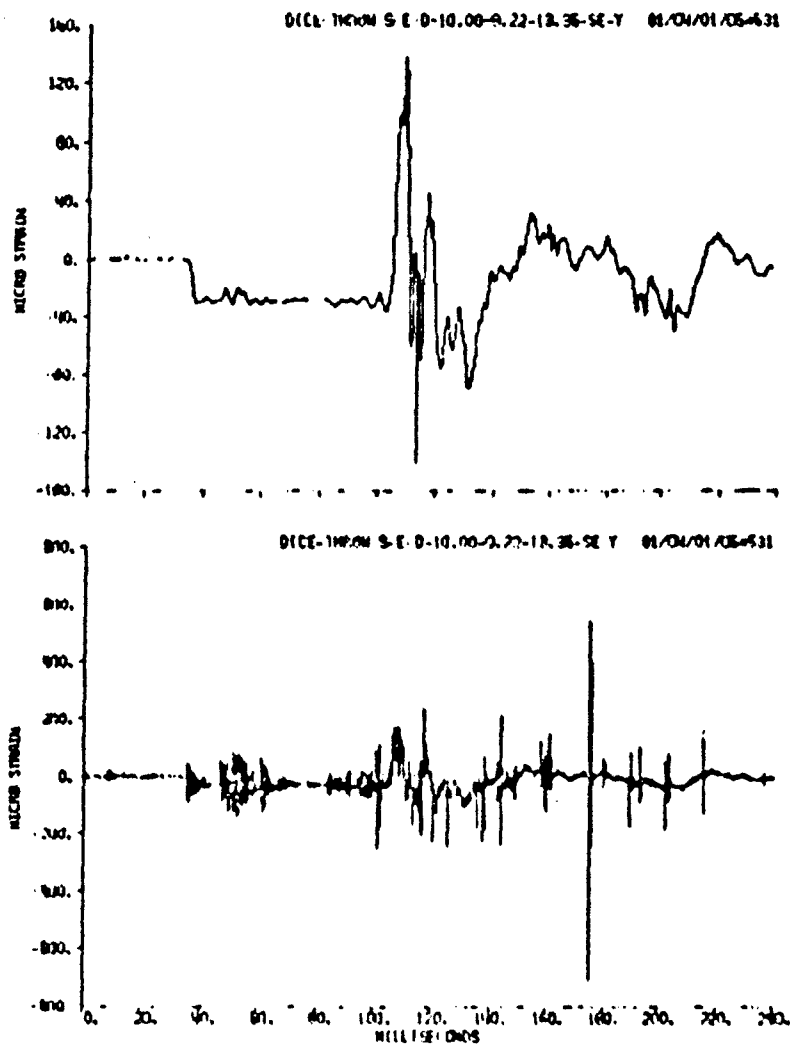




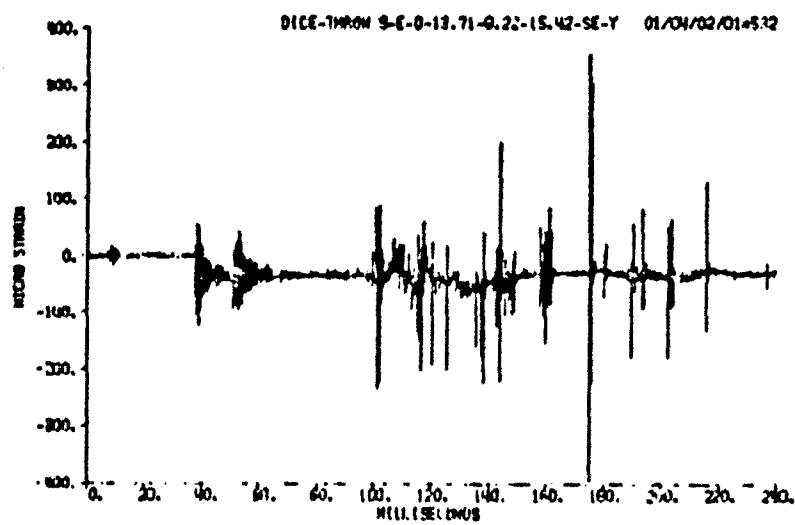
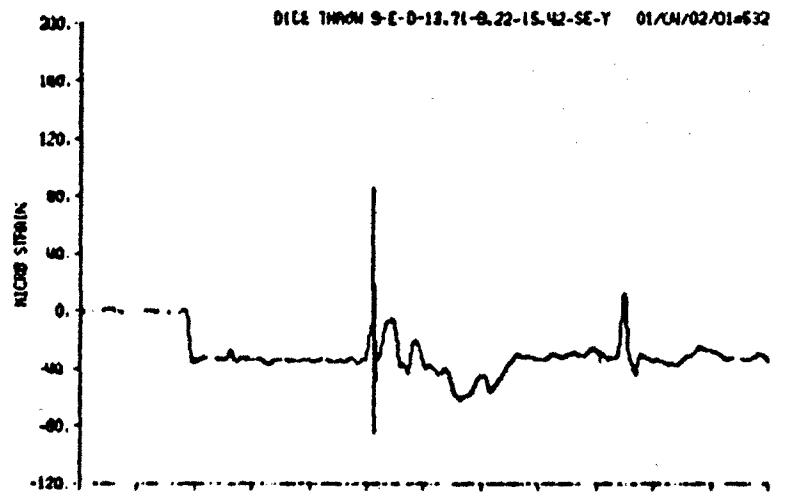
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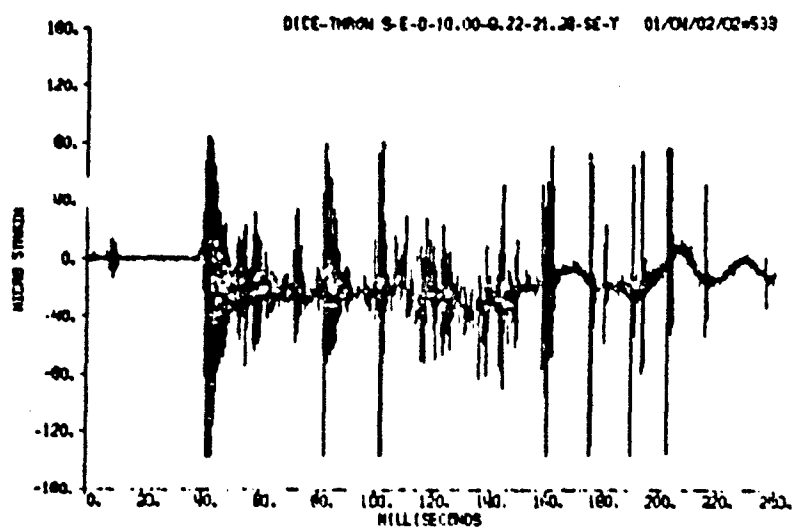
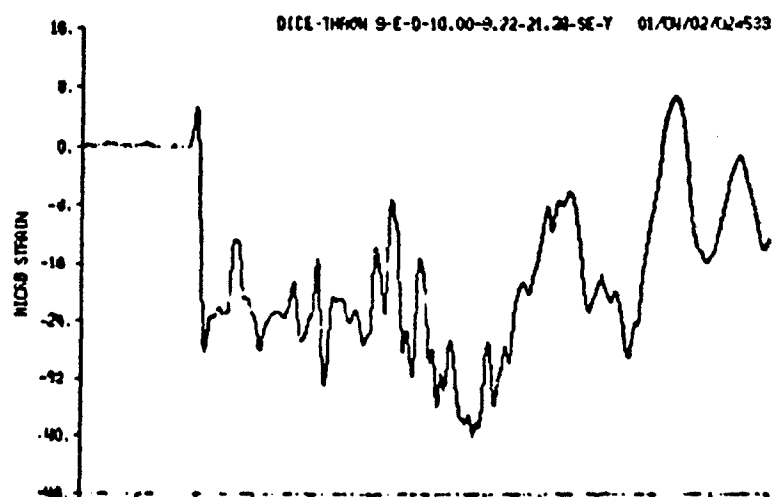


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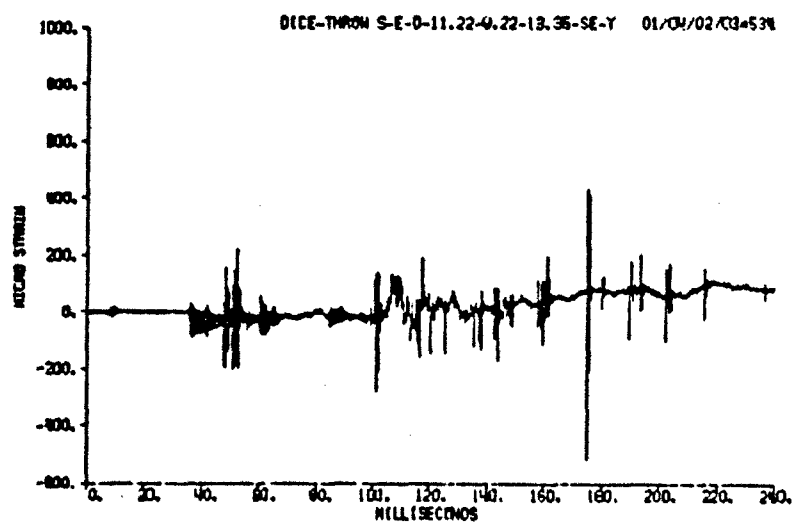
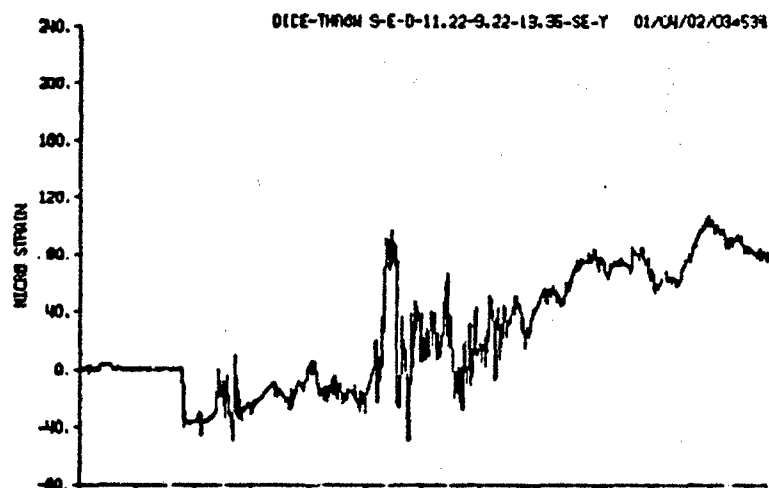
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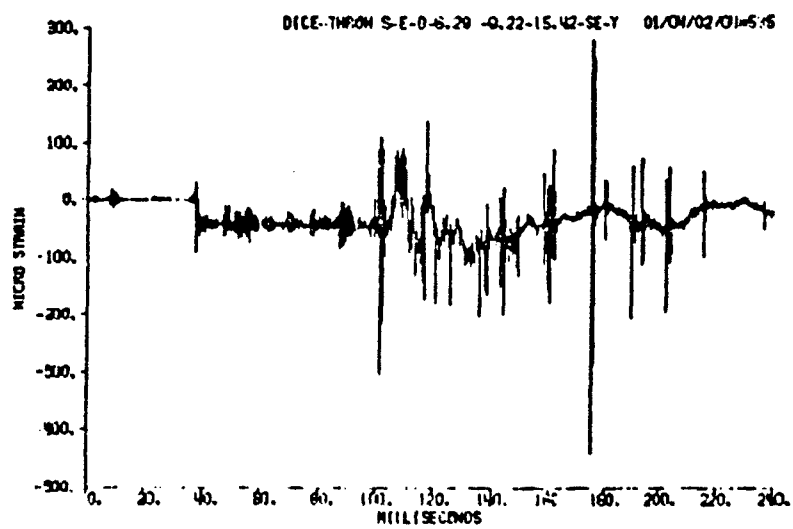
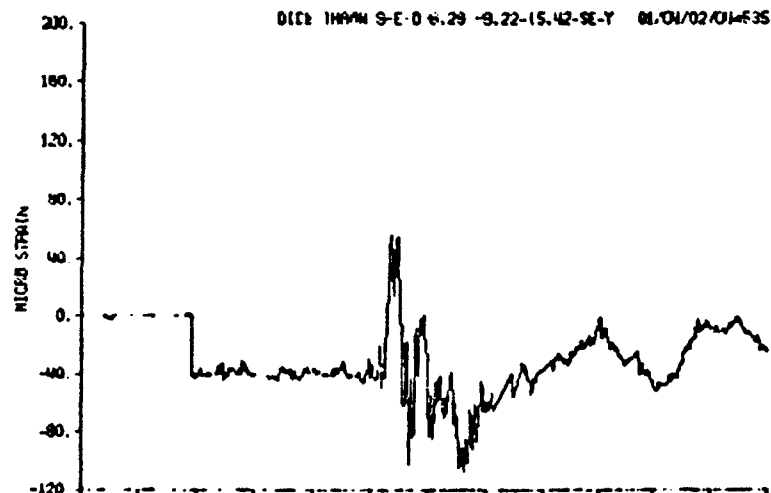




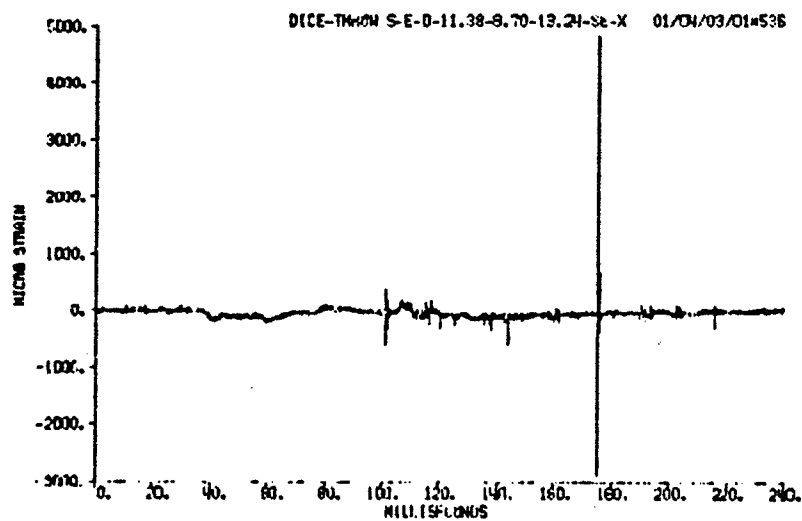
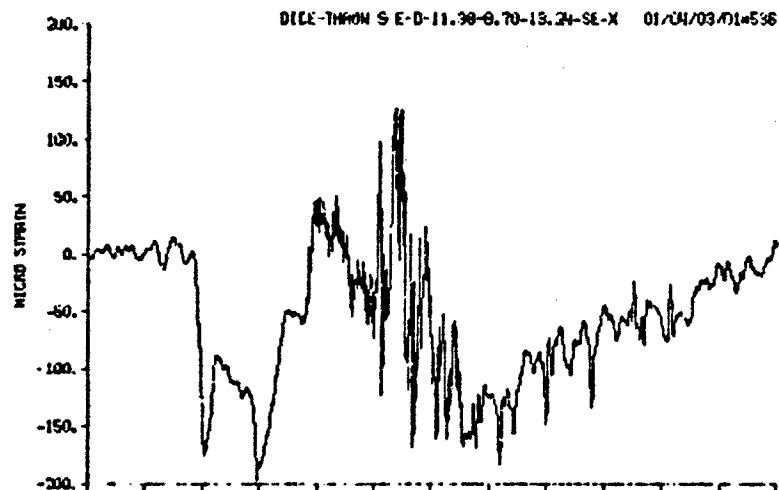
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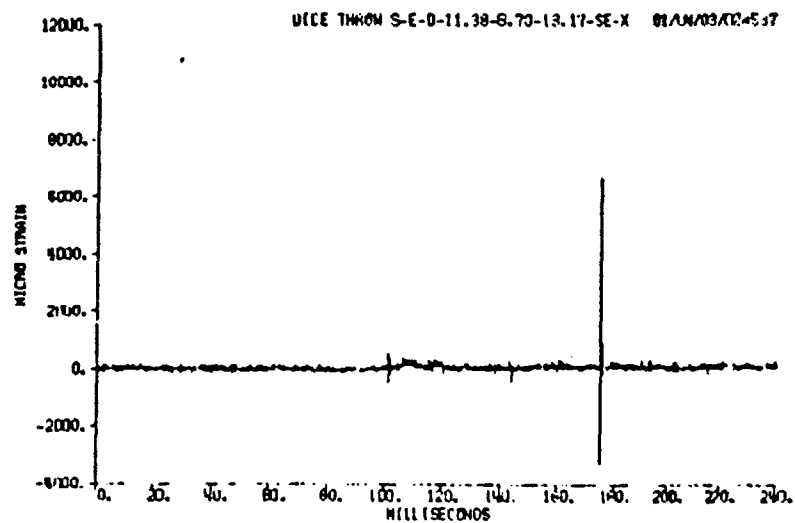
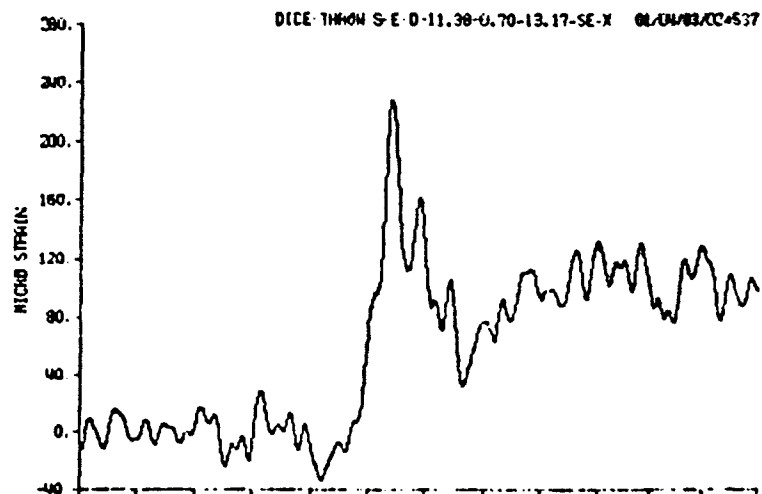


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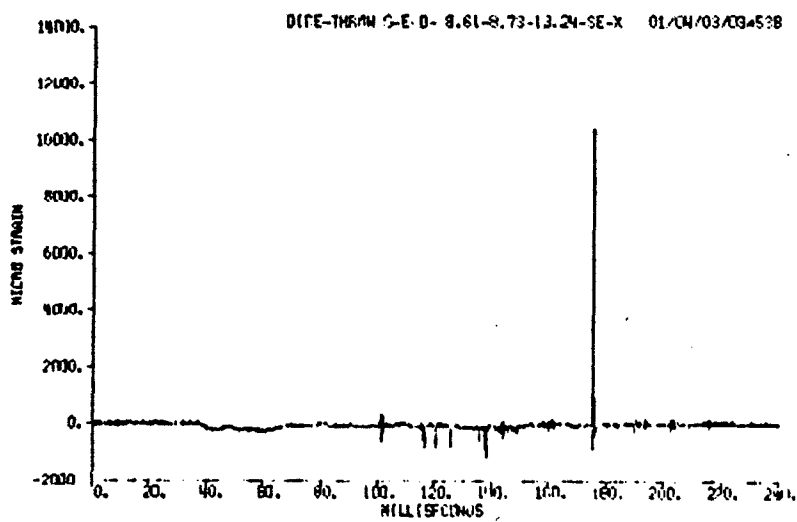
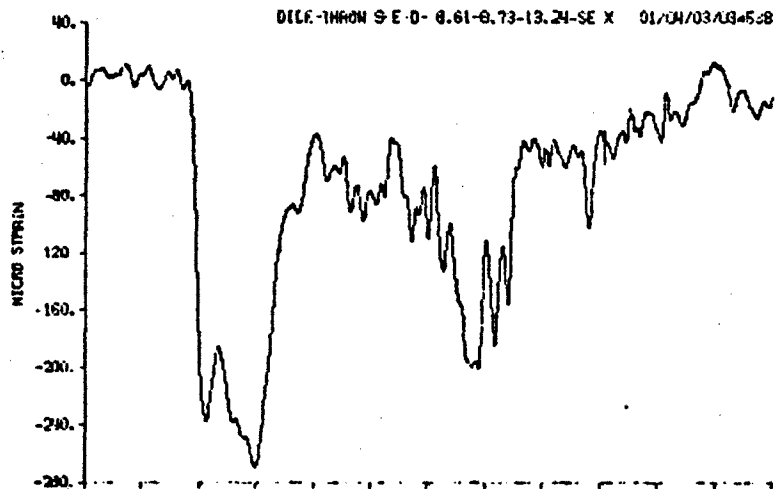


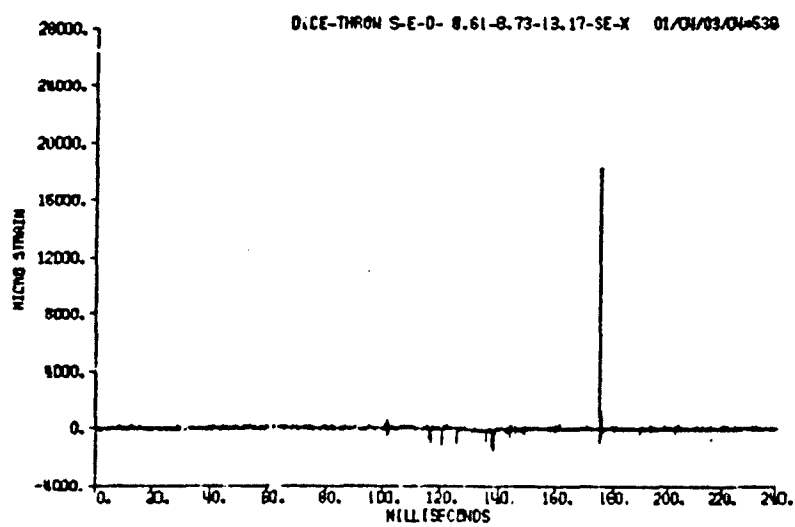
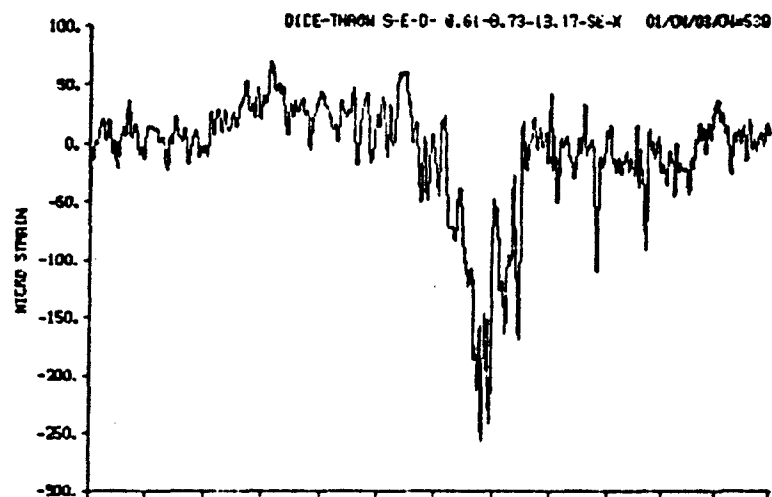
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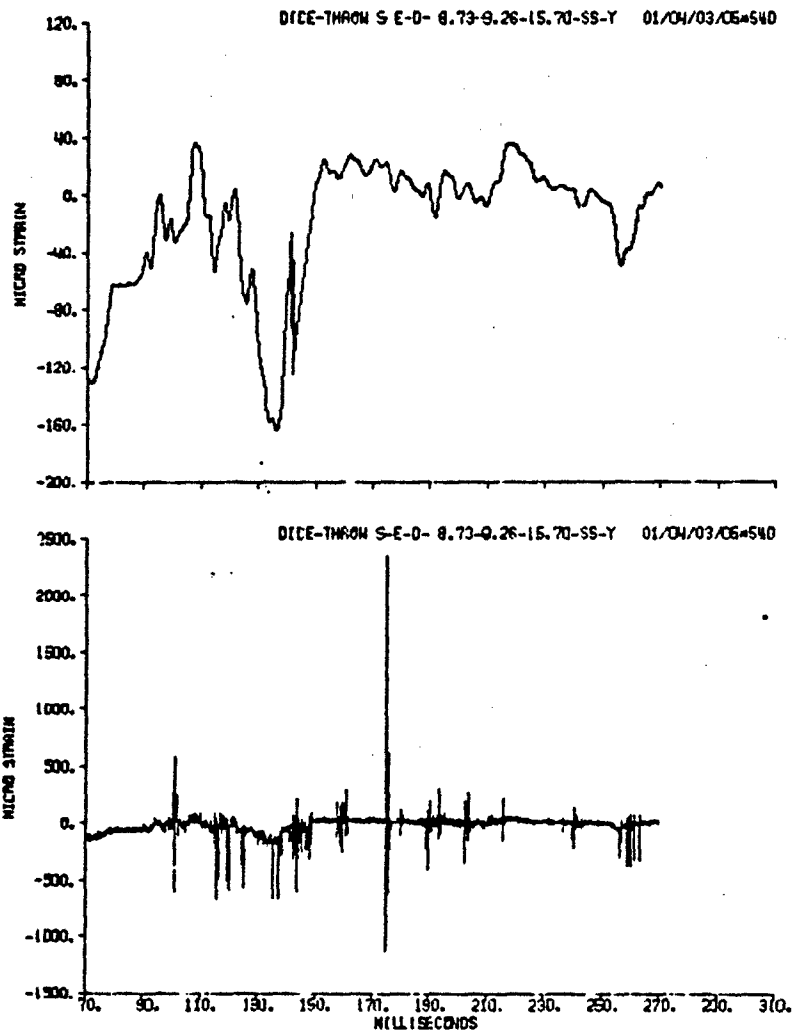


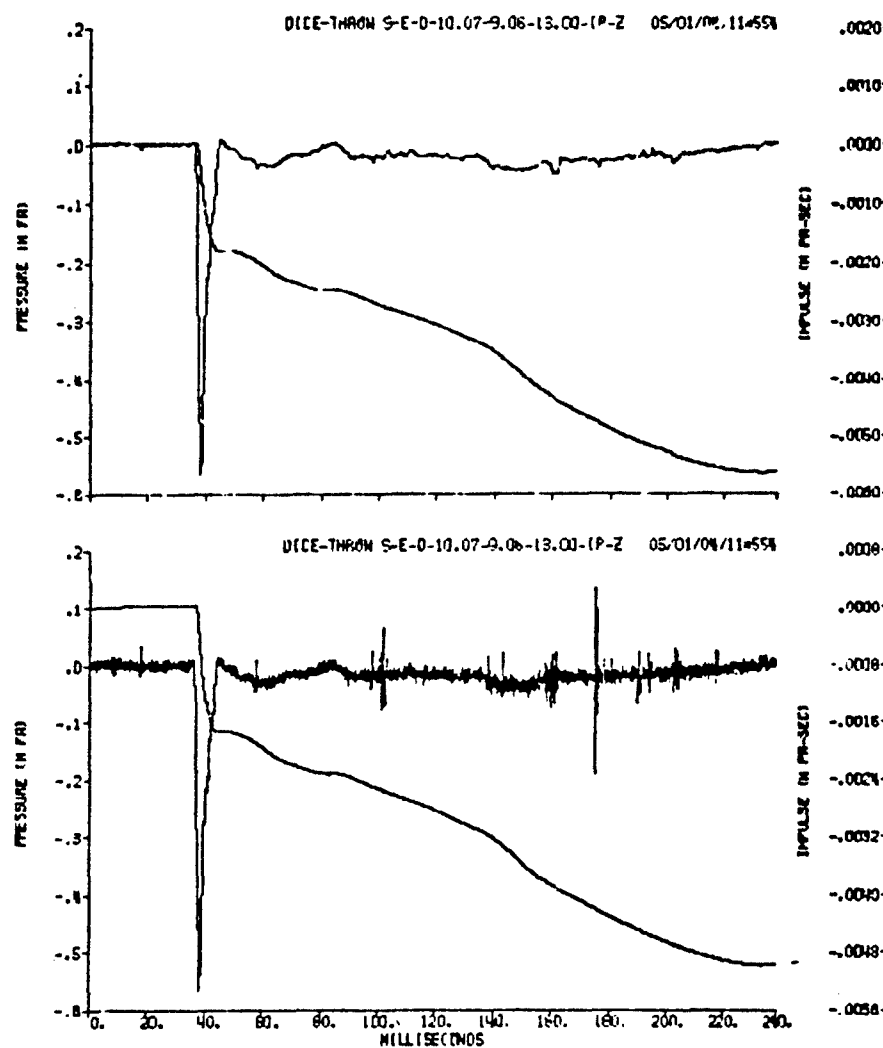
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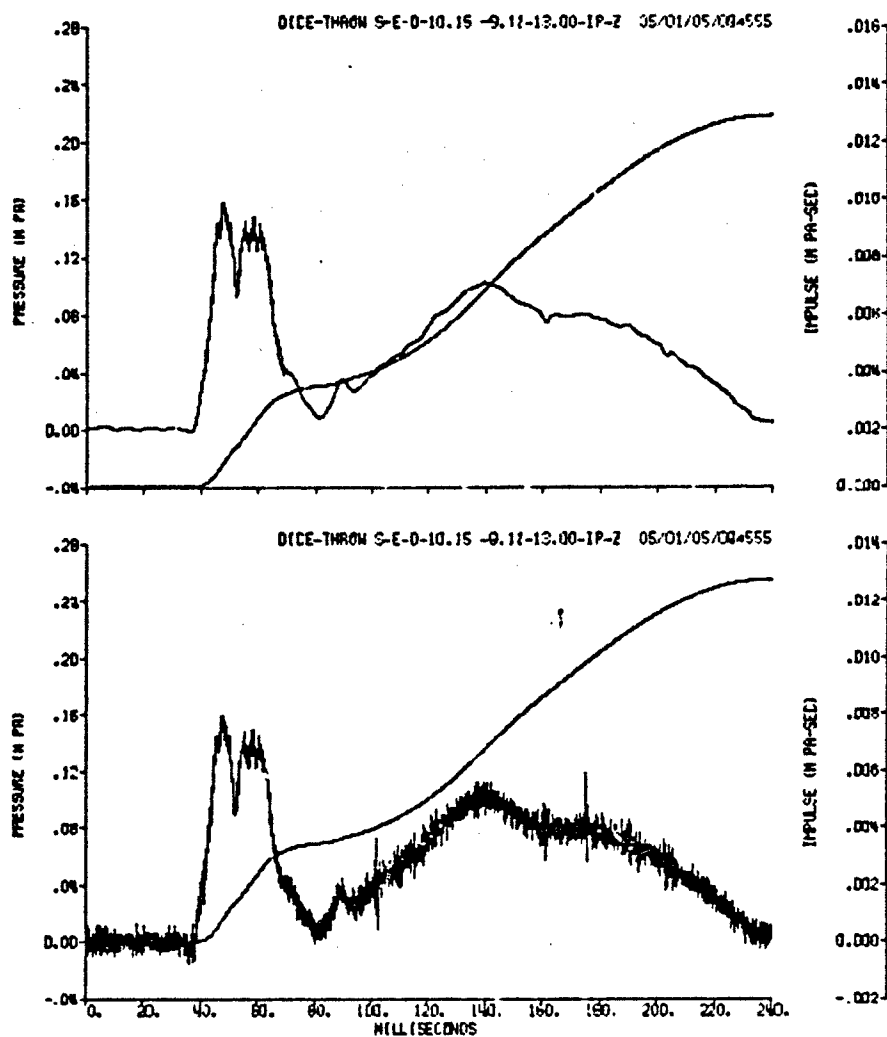


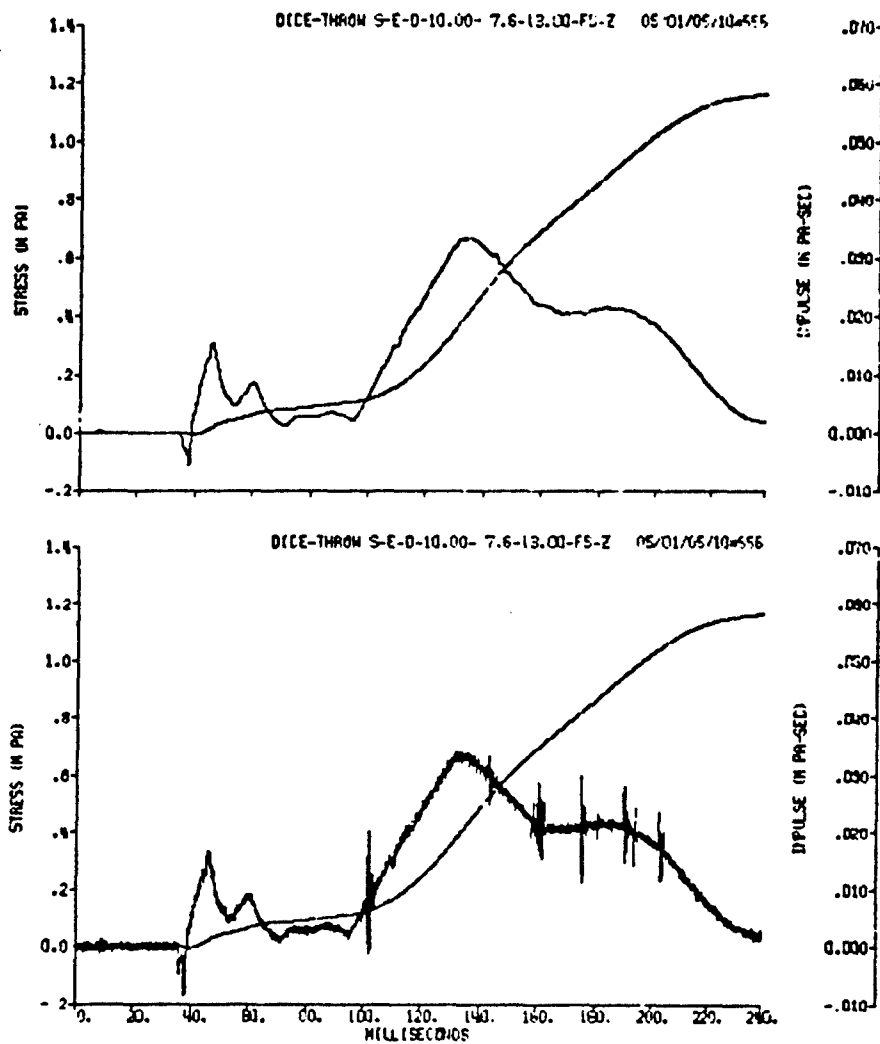
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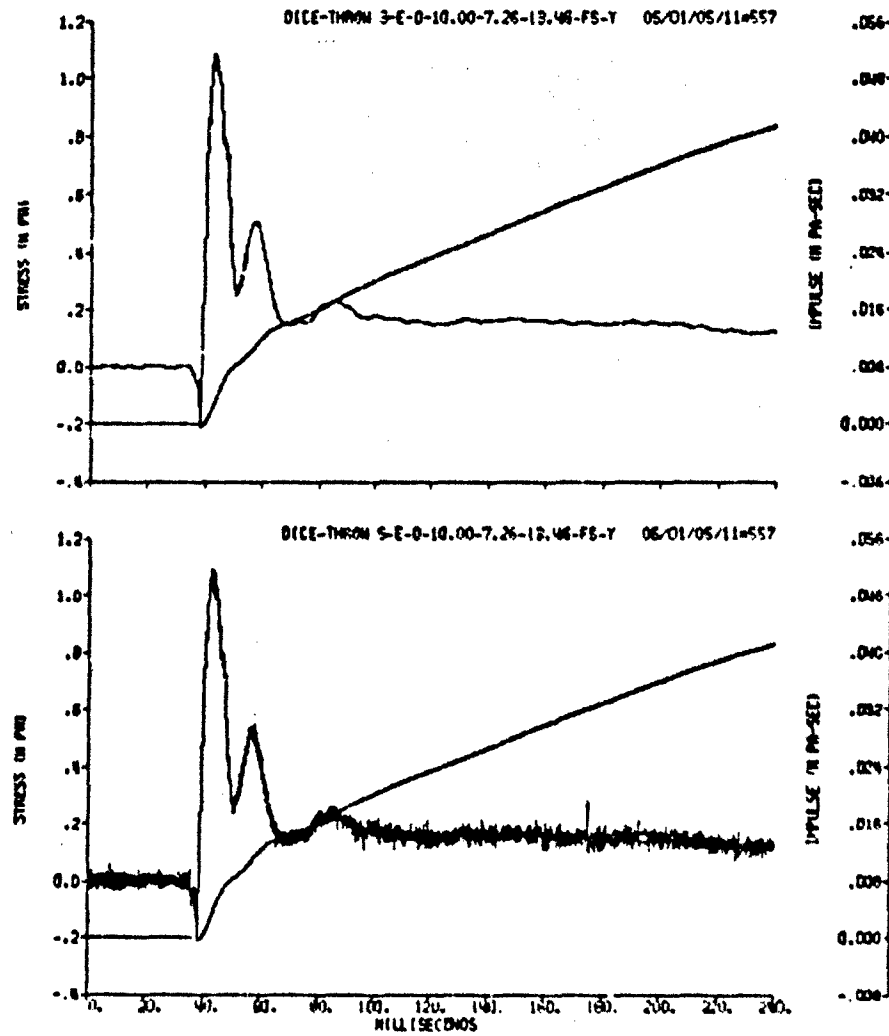




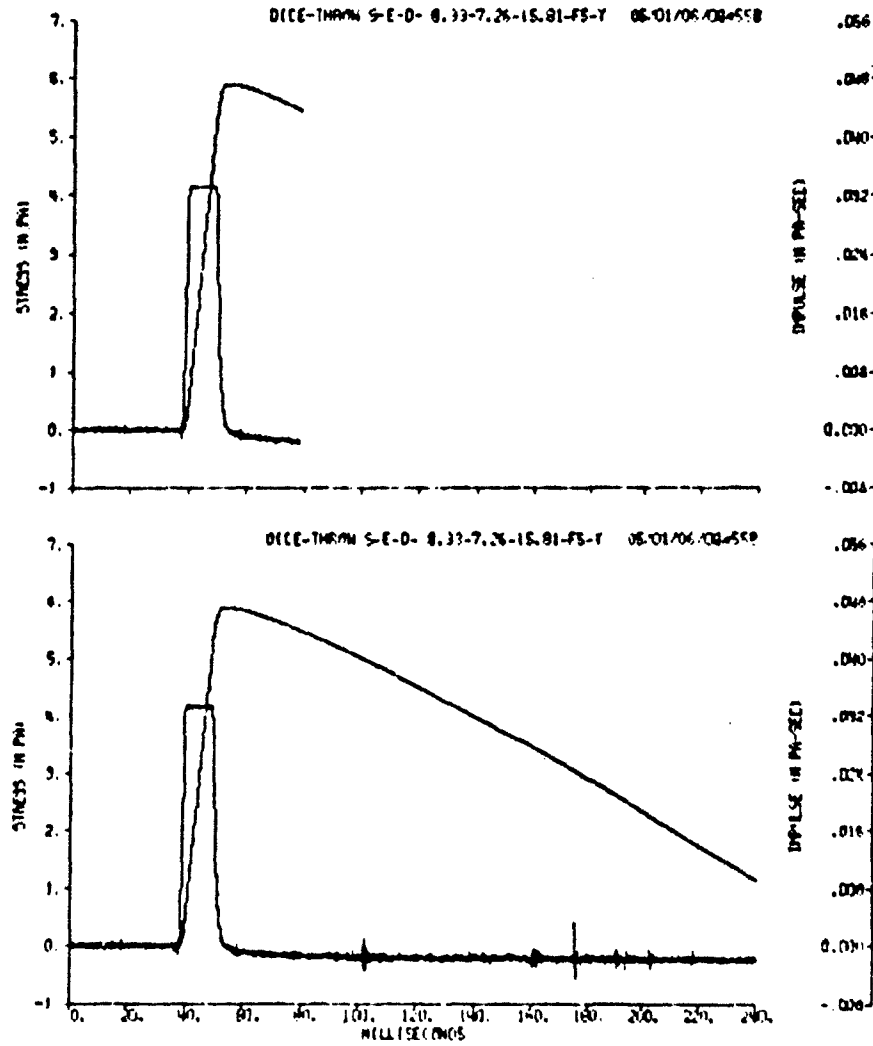




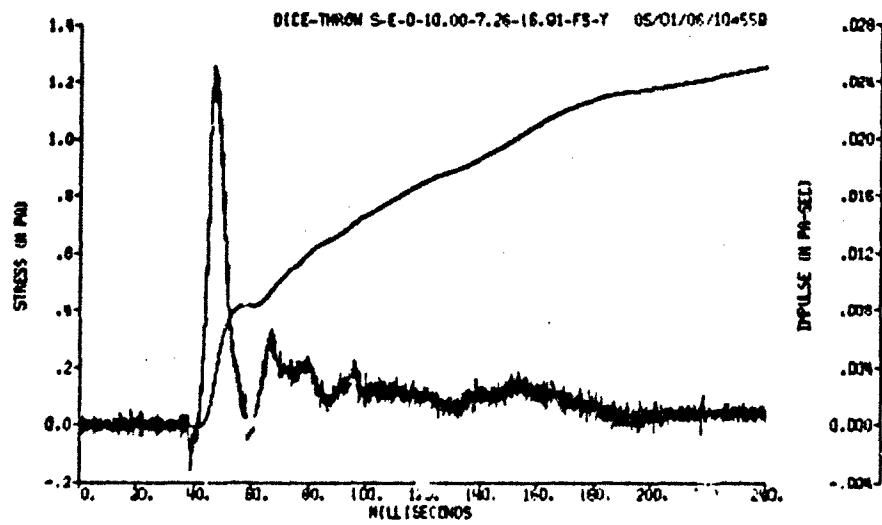
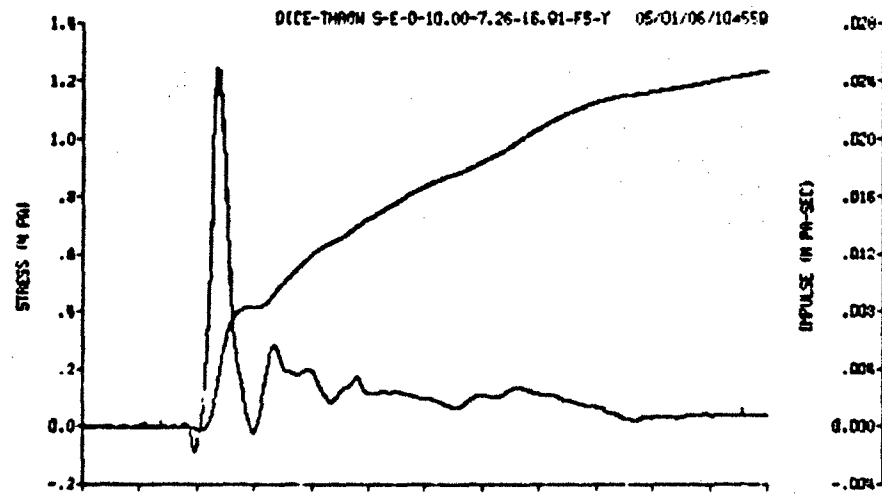
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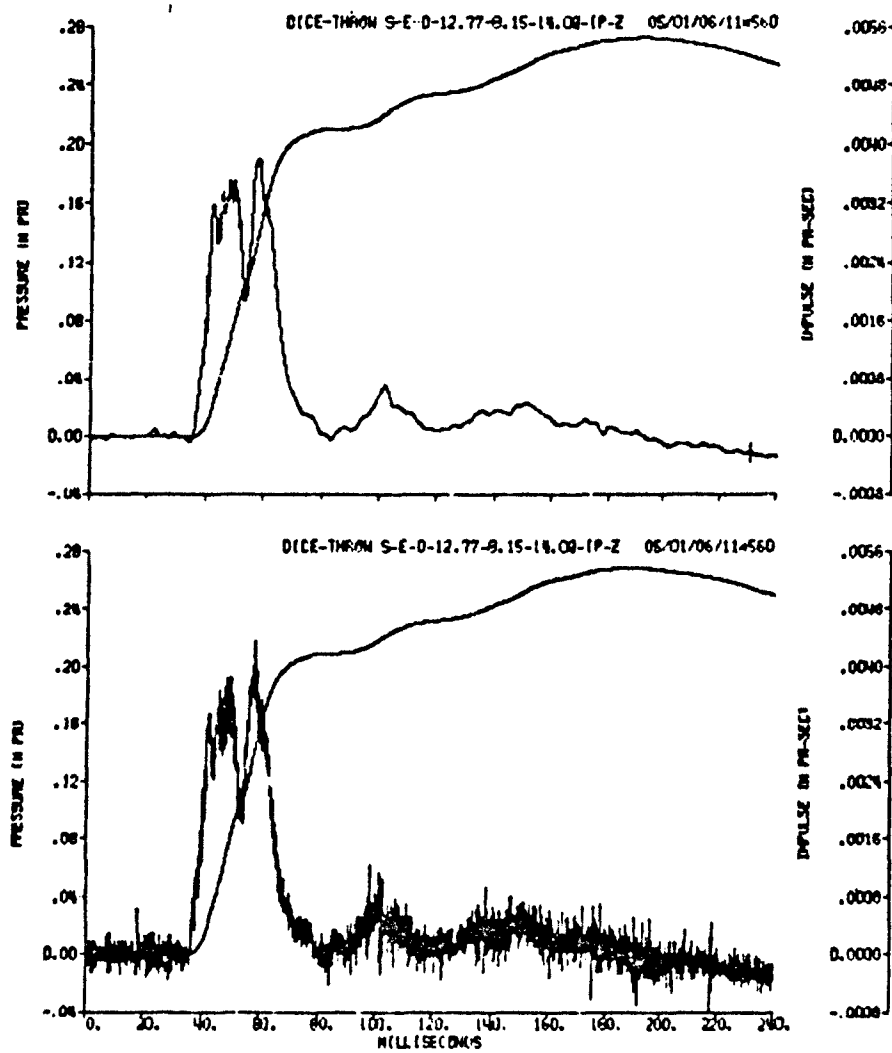
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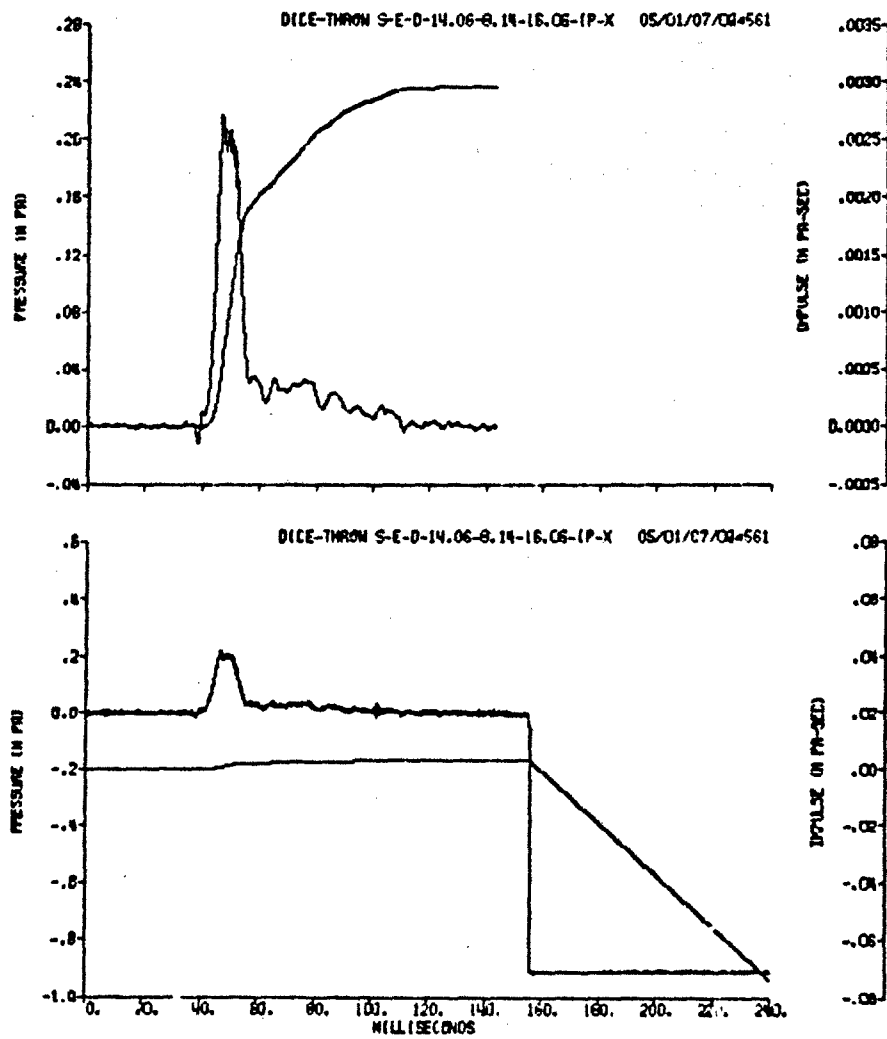
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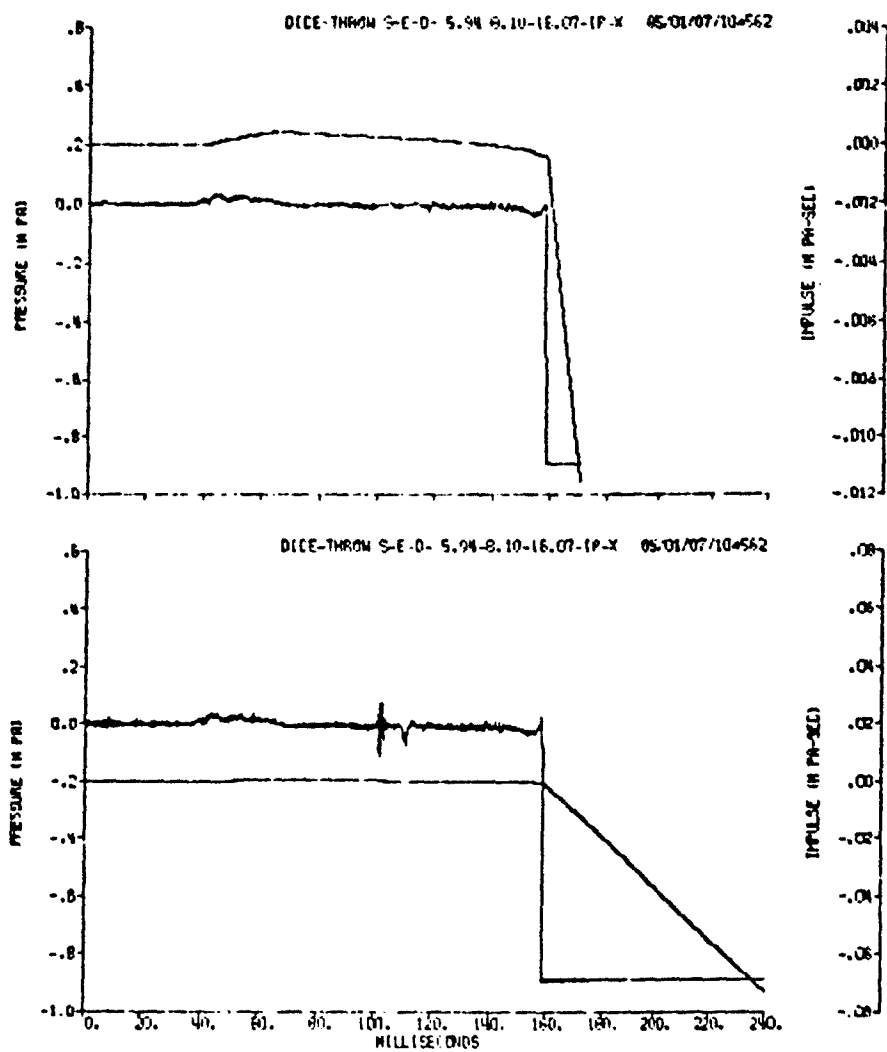
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